SUGGESTIVE HINTS

TOWARDS

IMPROVED SECULAR INSTRUCTION

MAKING IT BEAR UPON

PRACTICAL LIFE.

INTENDED FOR THE USE OF

SCHOOLMASTERS AND TEACHERS IN OUR ELEMENTARY SCHOOLS,
FOR THOSE ENGAGED IN THE PRIVATE INSTRUCTION OF
CHILDREN AT HOME, AND FOR OTHERS TAKING
AN INTEREST IN NATIONAL EDUCATION.

BY THE

REV. RICHARD DAWES, A.M.

DEAN OF HEREFORD.

Mens sibi conscia recti.—VIRG. *Æn.*
A good intention.

FIFTH EDITION.

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"Our most important are our earliest years;
The mind, impressible and soft, with ease
Imbibes and copies what she hears and sees,
And through life's labyrinth holds fast the clue
That education gives her, false or true."

COWPER

C. AND J. ADLARD, PRINTERS, BARTHOLOMEW CLOSE.

PREFACE.

The reader must not expect anything like perfection in the following pages, or that the matter which they contain is arranged in the best possible order; they are intended to give an idea of what is taught in the school here, and the manner of teaching it: the Author feels that if anything of this kind had fallen in his own way when this school opened, it would have saved him much trouble; however, without apologising for their imperfections, or attempting to point out their merits (the former of which others will but too readily see), such as they are, "he casts his bread upon the waters," hoping that it may in some way or other advance the cause of education: there will, no doubt, be found in it some chaff, but not unmixed, he is willing to hope, with some wheat also, which may be worth picking out: on the whole, as the man who purchased an axe of the blacksmith, which he wished to have all over polished like the edge, to which the latter agreed on condition that he would turn the grindstone, but finding the labour of so doing greater than he expected, said, he was not quite sure that he did not prefer a speckled axe to a bright one; so I feel myself obliged to let my axe go forth with many specks upon it; however, such as it is, take it, reader! profit from the bright spots, if it has any, and be lenient to the specks.

King's Somborne; *April* 18, 1847.

The Third Edition has been considerably enlarged in the body of the work, and in the general remarks on the state of the rural population: an appendix of tabular matter of a useful kind has also been added, and the reader will find considerable additions to the introductory matter.

April, 1849.

The favorable reception which former editions of this little work have met with, induces the Author to hope it may have been found serviceable to the cause of education. The Fourth Edition is offered to the public, with slight additions to the former.

January, 1850.

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INTRODUCTION.

Addison, in one of his numbers of the 'Spectator,' tells us, that the common people of his day were very fond of a little Latin, and intimates that the reason of this was, because they did not understand it. Now the opinion I have formed of the people of the present day is, that they do not like a thing unless they do understand it; and although I have placed a few Latin words in the title-page of this book, this is not because I think the words will be approved of where they are not understood, nor from any wish to make the book appear more learned than it is, but simply for this reason—that the words themselves briefly express, in a portable shape for the memory, what I wish to have credit for in offering to the public a Second Edition of these 'Suggestive Hints on Secular Teaching,' viz. "a good intention;" and however imperfect they may be in other respects, with this impression on his mind, the reader will, I trust, overlook many defects which he might otherwise be inclined to criticise, and see something of usefulness in what is well meant, although it may not in reality be all that he had expected.

It is from no love of authorship that I am offering these remarks,—remarks, let it be observed, which have arisen entirely from experience in a parish school,—but from a wish to promote that kind of education among the middle and lower classes, which at the same time that it bears upon their industrial pursuits, leads to an improved moral condition, by instilling in early life those feelings of self-respect and self-dependence, and those principles of honesty and truth, which ought to be the guide of every one who lays claim to the character of a Christian man.

I am the more induced to do this, from seeing that the rising generation about me, and with whom I am more immediately concerned, are made happier and better by this education,—that it leads to greater propriety of conduct in all the relations of life, and that those who have remained longest at school have generally turned out the best, and have given a proof that the longer they remain the greater is the security of their becoming, in their respective stations, what the friends of education expect them to be.

The value of education of the labouring classes; or, in fact, of

any other class, cannot be said to depend solely on the amount of knowledge given at school, but rather on the tendency which such knowledge has, to make them alive to the humanities of life, to fit them for their industrial occupations, to raise them in the scale of thinking beings, and make them feel what they owe to themselves and to those around them—to open out to them those sources of fireside amusement and of instruction which the art of printing has brought within the reach of all who are educated.

Now to effect this, the mere reading by rote is not sufficient, and it should be the aim of the schoolmaster, as far as he has it in his power, to give the children a knowledge of the structure of their own language—to enable them to get at the grammar of a sentence—to take it to pieces and reconstruct it; and, unless children are left at school until this can be done, and they are enabled to get at the meaning of an ordinary book without difficulty, little use will, I fear, be made of it in after life, and the fireside will not become, what it otherwise might be, through good books—a school through life.

A celebrated writer of the present day, has said, "The English language is a conglomerate of Latin words, bound together in a Saxon cement; the fragments of the Latin being partly portions introduced directly from the parent quarry, with all their sharp edges, and partly pebbles of the same material, obscured and shaped by long rolling in a Norman or some other channel." Now, although this definition is somewhat geological in its language, as the author intended it to be, yet it is a very forcible one, and indicates clearly that the way to get at the knowledge of this conglomerate mass, must be by taking it to pieces, and examining the separate parts; and, when the schoolmaster can do this himself, he will be able to bring his knowledge to bear in teaching others.

How important, then, that he should be able to unpack this conglomerate—to separate the cement from that which is imbedded in it—to show to his more advanced classes the origin of the different words of a sentence—how words of a Saxon or a Latin origin vary in the modes of inflection—how they have been introduced—to show how some belong direct to the parent quarry; how others, by rolling about in different channels, have had "their rough and sharp edges" rubbed off—the force and origin of the prefixes, &c.

This points out a most useful direction for the studies of the schoolmaster in this particular branch of knowledge.

With respect to this book itself, it does not profess to teach the schoolmaster the subjects he ought to have a knowledge of; its object is rather to point out to teachers, both in our elementary schools and in private families, common-sense modes of applying their knowledge, and of bringing it to bear upon their teaching;

but without particularising the leading features of it, it is an attempt to introduce into our elementary schools more of science, and a knowledge of scientific facts bearing upon the arts of life, and of every-day things, than has been hitherto done.

It is a fact almost unaccountable, and certainly curious to reflect upon, how few there are, even in any class of life, educated or uneducated, who are acquainted with the philosophical principles of those things which they see in action every day of their lives, and which are in so many ways administering to the wants of social life, —truths easily understood when explained by experiment, and so important in themselves to mankind, that the names of the discoverers of them are handed down from one generation to another for the admiration of future ages, and as the great benefactors of their species.

No one denies the importance of this knowledge when applied to the arts of life, and how must the progress of civilization, and of the great interests of mankind have been advanced by it, which makes it more strange that so little of the intellect of a country should be brought to bear upon it.

This is perhaps in some measure owing to its being supposed, that a considerable knowledge of mathematics and of arithmetic is necessary, and from a prevailing notion that such subjects are, even when illustrated by experiment, difficult to understand; but Dr. Arnott, in the Introduction to his Natural Philosophy, justly observes, "There are few persons in civilized society so ignorant as not to know that a square has four equal sides, and four equal corners or angles, or that every point in the circumference of a circle is at the same distance from the centre. Now, so much of unity, simplicity, and harmony is there in the universe, that such simple truths as these are what give exact cognisance of the most important circumstances in the phenomena and states of nature;" an acquaintance with the common rules of arithmetic, and of the measures of quantity, which fit a man for ordinary occupations, are quite sufficient for all that is wanted here.

Hitherto all classes seem to have taken for granted, that the labouring part of the community had no business with anything where the mind is concerned; but why should not the miner, whose life may have been saved over and over again by the safety-lamp of Sir Humphrey Davy, know something of the principle to which he owes his safety, and of the philosophy of it—many of the accidents which occur from mere carelessness would be avoided by it; or the plumber, whose business it is to make a pump, be taught, however much the sense of sight may mislead him, that air and gaseous substances, which he cannot see, have weight, and that these and fluid substances press equally in all directions, and he will then understand why his mechanism succeeds, and the water

rises, which, without some knowledge of this kind, must appear to him a kind of witchcraft; or why should not the labouring classes have it shown to them during their education at school, that the burning of charcoal, or of chalk and limestone into lime, &c., gives rise to a kind of substance which they cannot see, but when breathed into the lungs is fatal to animal life, and its being heavier than common air makes the burning of charcoal in small rooms a very dangerous thing. From a want of a knowledge of this, many lives have been lost.

With a view to encourage a knowledge of the applications of science to the occupation of the country in my own neighbourhood, during the autumn of last year, a course of six lectures on the Chemistry of Agriculture was given at the schoolroom by a gentleman who had made the subject his professional study, and who was well qualified to give an interest to it, not only from his knowledge, but from being a good manipulator in the experiments necessary to illustrate it.*

My first intention as to these lectures was for the instruction of the school itself, and of the schoolmasters of the neighbourhood, but finding that many of the gentlemen and also of the farmers in the neighbourhood wished to attend, I invited all to do so who were so inclined, and with the exception of two extremely wet days, the attendance was good.

Many of the gentlemen took a considerable interest in them, and although the farmers, I have no doubt, felt they could not carry away so much as they had expected, yet the indirect effect of such lectures is good in an educational point of view—it creates a wish, and that a very natural and a very laudable one, on the part of the parents in the middle classes, that their children should have an opportunity of acquiring a knowledge of the appliances of science to those pursuits in life in which they are so much interested.

The conclusion which I drew from the experiment, and which I think is a correct one, was, that a short course of lectures, and made as practical as possible, and repeated at intervals in different parts of a county, would be attended with great good, and in the end lead to an improvement in the education of agricultural youth, which it is most desirable to effect. It is not to be expected that those who are grown up, and whose habits are formed, should enter into it as a science; their previous education has not fitted them for it, and their modes of thinking are against it; nor can they stand anything like a continuous course of lectures, but they carry

* For these lectures I have to thank Mr. Edmonson, the head of the Queenwood Agricultural College, and Mr. Frankland, the chemical lecturer there, by whom they were given; both these gentlemen entered into the subject from the same motives as myself, viz. a wish to promote the education of the neighbourhood.

away facts bearing upon some particular point which they understand, talk about them afterwards, persuade themselves that such knowledge is good for their children, and in this way an influence for good on the education of the rising generation is likely to spring up.

In the schoolrooms here, these lectures were turned to good account, both as instruction to the teachers and to the older children, and the outline given filled up by experiments and explanations afterwards.

To speak even of teaching anything of science as a part of the education of village children, or of the teacher having such a knowledge of these subjects as to be able to bring it to bear upon his teaching, is, I am perfectly aware, by many looked upon as visionary, by some as useless, and by others even as mischievous. Now many of these are carried away by their prejudices against such instruction, without knowing or considering seriously what is meant by it; but, on the subject of chemistry, for instance, when it is considered that chemical processes are involved in everything which we eat or drink; in the preparation of every material used for our clothing; in every change of the material world, whether animate or inanimate, with which our senses can make us acquainted, some knowledge of these processes must be looked upon both as interesting and highly important, and ought to be understood by those with whose pursuits and employments in life they are so intimately connected.

Besides, it seems to me even highly instructive that an intelligent child should be made to seize a firm hold of so much of this subject as to enable the mind to get out of the habit of viewing all the different productions of nature as being made up of substances having nothing in common—that earth, iron, stone, air, water, animal and vegetable, as things having no single element of the same kind in their several compositions—not having the slightest idea that all the infinite varieties of the material world around us are only different compounds of a few simple elements,—that the mind should be able to correct this impression by seeing a few of these substances taken to pieces by experiment, their simple elements tested, and shown to be the same in each, is of itself good, and opens out a train of thinking, which in some may lead to most important results, by calling into use those faculties of the mind which God has given them.

The workman who is acquainted with the facts in science connected with his occupations, becomes less of a machine than the one who is ignorant of them, is every way more useful to his employer, and is himself a happier and a better man; for it is acknowledged, that the better educated workmen of all countries are distinguished by superior moral habits in every respect—they

are more sober and discreet, and their enjoyments are of a more rational kind.

Of the necessity of an improvement in their social habits among the labouring classes of this country, whether mining, agricultural, or manufacturing, no one can doubt; but the Report of the Rev. H. Moseley on the State of Education in the Midland Districts for the year 1846, addressed to the Council on Education, which I have lately read, discloses many features in the character of the mining population in and about Bilston, and which of course is the same in other mining districts, which I must confess were new to me, and which one cannot read without great interest, but it is an interest of a very painful kind.

The habits of life which prevail among this population, and their social condition, as seen in the description of the Bilston market, and an appendix to the Report, are most instructive, as to the effect of ignorance upon a labouring community earning high wages—ignorance, as Mr. Moseley says, carried out into action; and adds, "whenever ignorance is associated with 'high wages,' they will, I believe, become, as they are here, a *curse;*" and the Report goes on to say, "rude as these men are in their manners, and wholly uneducated, yet when the opportunity has been afforded them, they have shown themselves capable of deriving pleasure from other than sensual gratifications and low pursuits."*

From the Report which has lately been published on the State of Education in Wales, there is one thing which appears very remarkable, independent of the lamentable state of ignorance which seems generally to prevail, which is this: that in those districts where the people seem to have a very considerable knowledge of Scripture, the state of their morals is of the lowest and most degrading kind—in this fact the evidence of the clergy of all denominations seems to agree. Something of the same kind I have myself observed in the south of England, and it is by no means an uncommon thing to find in some, nay, I should say in many of that class, an aversion to their children being taught anything of a secular kind—as if secular instruction partook in some measure of the nature of sin; this is no doubt a state of gross ignorance greatly to be pitied, and which will in the end be corrected by the influence of a better educated class, as this becomes diffused among them; but the singular and almost unaccountable part of it is, that this apparent knowledge of Scripture should have so little influence on

* The opportunity alluded to was a course of winter lectures, established for their benefit by the Rev. J. B. Owen, the incumbent, an account of which, in a letter of Mr. Owen's in the Appendix to Mr. Moseley's Reports, is well deserving the attention of those more particularly who are engaged in education in populous districts.

their moral conduct; that it should never enter into their minds (or, if it does, they do not regard it) that Scripture truths are intended as rules of life; whether the sort of familiarity which they have with Scripture phrases, and the constant habit of interweaving them into their conversation, can have led to this I do not know, but such is the fact.

Nor is this even in England confined to the labouring class; there are many of those of the class above them, particularly of those who are uneducated, to whom the same remarks would extend—a man who gravely tells you, "I does the best I can to get an honest living," and perhaps quotes some text in Scripture to support his views, at the same time knowing that the very principle upon which he acts towards those about him makes it almost impossible for them to do so, cannot be said to make the proper application of his religious knowledge.

I observed another thing in the same Report, of a more cheering kind, that it had occurred to some of the Educational Committees to combine the education of the middle and the lower classes, and that in this way funds might be raised for proper education. One would suppose that the social state of most of the districts in Wales, the number of small farmers, tradesmen, &c., would be particularly favorable to such views, and that, if worked out as they ought to be, they could scarcely fail of success.

The present Bishop of Sodor and Man, thinking this plan well calculated for the state of society there, is endeavouring to introduce it throughout the island; and it appears from a Report lately made by Mr. Moseley to the Council on Education, that some plan of the kind had been thought of by the good Bishop Wilson, for whose memory the inhabitants retain so lively an affection, that its renewal now will be received with the greater interest. The general feeling in favour of education, as shown by "the framework," as Mr. Moseley terms it, in their laws regarding schools, and in the feelings of all classes in favour of it, dispose one to think that these matters have been much more cared for there than with us; perhaps their vicinity to Scotland, and a knowledge of its school-system, may have led to it. In their present position, and with the Minutes of Council to assist them in their poverty, they have all the elements of success.

An important feature in the school here, and one which is worthy of the attention both of school committees and of schoolmasters, is the amount of payments both for schooling and for books; this arises from the union of the children of different classes, also from many children coming from the smaller neighbouring parishes.

This amount of payment, both in a moral and in a pecuniary point of view, is important, and one in the success of which the

schoolmaster is deeply interested—his improved social position almost entirely depends upon it; and if the better class of schoolmasters will reflect upon this in all its bearings, they will see how much their success in life depends upon their acquirements and their capabilities of teaching being equal to the want of the middle, as well as of the labouring classes.

What is wanted in our rural districts, most assuredly, is an improvement in the quality as well as in the quantity of instruction, and the mere extension of the Sunday-school to week-day teaching is not sufficient; but to attempt anything beyond an improved dame's school, or one fit for the younger children is, in very small parishes, on account of the expense, a thing manifestly impracticable; nor, in fact, would it be necessary with the class of schools I am advocating, numerously spread about the country, and to which the bigger children in the small parishes would resort. And in this way I am thoroughly persuaded an improved system of education may be worked out, of a very high character, almost self-paying, and which would in a few years have a firm hold on the public mind.

Nor should it be said, that in order to effect this, individuals can do little; on the contrary, they may do a great deal,—every school of an effective kind, conducted in such a way as to gain a footing for education in a neighbourhood, is of immense importance, whether it is the result of an individual effort, or not,—it is good, not only as regards the locality in which the school is, but good as an example practically worked out, and which has much more influence than a thing merely carried out on paper; and every one who reflects must see, that perfect and general plans of education must, like all other things of human contrivance, arise gradually, and cannot, in a country where opinion is so much divided as in this, be at once established.

Let the farmer and the tradesman weigh well in their minds what they will save upon each child educated at the parish school, and the kind of education he will get—let the landlord consider the interest he has in bringing a cheap education within the reach of his tenants, and how much they would rise in respectability as a class, by being better educated—and let both classes consider the mutual duties, and the moral obligations they are under to improve the condition of the labourer, both physical and moral, who is equally necessary to them both: if all would reflect in this way, and could be brought to see how much society at large would gain by this improvement in these links of the social chain, and how much the very slight fastenings which at present hold them together would be strengthened by it, the progress of education and of sanitary measures, would meet with less difficulty than it has hitherto done, and these would very soon be felt to be

both a benefit, and a source of increased happiness, to all classes of the community.

The rising generation of schoolmasters must not judge of the future from the past; hitherto they have been ill paid and little thought of, but very often this has arisen from their being ill qualified for the duties they had to perform: as an honest old dame said to one of the inspectors, "It is but little they pays me, but then it is but little I teaches 'em." In many cases, in such parishes as has a schoolmaster, he has been appointed not from any fitness for the office, but because he had failed in everything else, or some labourer able to read and write, and was made schoolmaster to keep him from the parish. The schoolmaster may rest assured of this, that the better he is qualified for his situation, the more he will make society feel his worth, and instead of appointing the worst men who can be found, as the rate-payers of a parish, when they have had a voice in the matter, have been apt to do, both labourer and employer will unite and struggle to get the best schoolmaster they can—the best qualified in every respect, and one who will make the importance of his office felt, by the better education he is diffusing among them.

Although much depends on the schoolmaster in the success of a school, yet much depends also on the books which are introduced: owing to a deficiency of these, and to a want of a fitting apparatus, &c., many of the schoolmasters have no chance of success; and I would observe here, that it is almost impossible to overrate the importance of introducing the system of the children buying their own books, the result of which is, that every fireside becomes a school.

In the selection of these, there should be no prejudices as to their being published by this or that Society: there are many which are good, published by them all; and I have introduced here some of the Christian Knowledge Society, of the Irish National Board, and of the British and Foreign Schools. It has been found that the children in some of the lower Reading Books have them almost by heart, so that it is really necessary to introduce a more extensive range of reading, and add to their stock of knowledge.

I am aware that prejudices have hitherto existed, more particularly in my own profession, with regard to the books published by the British and Foreign Schools, and this has greatly hindered a more extensive use of them. Now, as a set of educational books in secular instruction for our elementary schools they are very good, not only good in substance as to the reading lessons, but they contain also excellent hints, which will be found most useful to the teachers. The only fault I find with them is the price, and the committee would do great service to the cause of education if they could reduce them about 25 per cent., which I have no doubt would be made up by the increased sale. Those I introduced here

were No. 2 and No. 4; the price of the former is 9*d*., and it is the only book which has been sold in the school below the cost price, and which has only been done to the children of the labourer.

Arnott, in the Introduction to his Physics, speaking of a set of books of education in science, says,—"To have all the perfections of which they are susceptible, they can be looked for only from academies of science, or from an association of learned men; and even then, they cannot be compiled by each individual taking a distinct part or parts, but by the parts being undertaken conjointly by several persons, so that he who conceives most happily for students may sketch, he who is learned may amplify, he who is correct may purge, he who is tasteful may beautify, &c." The composition of this Book of Nature (as he calls it), he adds, "might be a worthy object of rivalry between nations." What might not be done for education by a set of books adapted to our elementary schools, and got up on this principle, and how worthy such an object is of the attention of our most talented men!

Now that extreme opinions on all sides are tempered down into something of a practical plan, it is to be hoped that prejudices and jealousies will die away, and that all will unite in supporting the present plan for the advancement of education, although it may not be the best according to their own ideas, yet it certainly unites in its favour a great part of the common sense of the nation, and will, if carried out in singleness of purpose, work better in practice than those who, from mere theory, have been opposed to it, are led to expect.

With respect to the Minutes of Council on Education, so far as I am capable of judging, I have always thought them fair in principle and judicious in their detail, and characterised by a great deal of talent in the way in which they have been worked out. They offer great encouragement to the well-qualified and efficient schoolmaster, both through an increase of salary and through the assistance of the pupil-teachers in the management of his school.

Some, I know, are of opinion that the standard of acquirements of the school-teachers and of the qualifications for pupil-teachers are too high. With respect to the acquirements of pupil-teachers, I feel persuaded, if the general standard were below what is fixed upon, and what in practice the inspectors seem to require, we should soon find a numerous class of pupil-teachers totally unfit for their position, and that the cause of education would, on account of the great expense attending it and the small proportionate results, retrograde rather than advance. No doubt a very great proportion of the present teachers are not qualified to teach what the Minutes require; but it is much better that they should be obliged to work up to a moderate standard, rather than that it should be

lowered to a point which would render it totally inefficient for the advancement of good teaching.

In carrying into practice the contemplated increase of salary to masters and mistresses, the examination seems to me defective, inasmuch as it does not make sufficient inquiry into the state and efficiency of the school of which the candidate is the teacher.

A man who is just leaving a training school, or has only lately left it, and during the last year or two been practised in composition —in examinations on paper, &c., will, as the examination is conducted, do much better than many of the really good, practical teachers, and whose usefulness as teachers has been proved by the state and efficiency of their schools. In this way there is great danger of the experienced, good schoolmaster being classed far below one who may not turn out half so useful when tried in the school. I think, unless the state and condition of a school is taken into account, many useful schoolmasters, and very deserving of the increase of salary, both from their past labours and their future promise of good, will be deterred from offering themselves. I don't know how far the continuance of an increase of salary depends upon the state of a school, but it is evident there ought to be some connection between them.

I see it stated in a new periodical, the 'Educational Magazine of the Home and Colonial School Society,' "what the country really requires is schoolmasters who have *professional* skill; or, in other words, who are well acquainted with the nature of children, and the way to deal with them: (we may add schoolmistresses, also, for the patient training and happy influences are invaluable.) Faithful teachers, of steady, hard-working, pains-taking habits, with a tolerably good English education, well informed in common every-day matters, grasping what they have acquired firmly, and having it ready for use; knowing something of the art of teaching, well trained to draw out the faculties of children, to teach them the rudiments of knowledge, as well as to read with ease, and to read fluently." Now, all this is very good as far as it goes, and will, in many schools, be all that is wanted; yet there can be no doubt, the higher the acquirements of the teacher, and the more knowledge he is able to bring to bear on his teaching, the more likely he is to succeed.

Although the attainments aimed at in some of the training schools may appear of a character beyond what is wanted in the lower class of schools, yet these very men of greater attainments are by no means beyond what is wanted in our larger elementary schools, and will, if they can unite in education the children of the employer and the employed, in the end be the cheapest schoolmasters, inasmuch as I am confident they will be the means of raising up a numerous class of self-supporting schools, and make the farmers

and tradesmen feel what they have hitherto never done, the real value of the village schoolmaster.

It may not be thought necessary, nor do I think that it is necessary, for the schoolmaster to teach Latin and Greek, and perhaps undue importance may have been given, or thought to have been given, to these in some of our Training Institutions, but it must be recollected that they are taught these in order to qualify them the better for teaching other things; and what I am holding out for is an amount of knowledge in the teacher which will make him worth having when he is sent among us, and by his teaching make the parents feel that education is worth paying for, and is one of the decent wants of life.

The kind of knowledge which appears to be most useful in our schoolmasters is sufficiently indicated in the following pages; and I think experimental science, and a knowledge of the science of common things, ought to form an important part of the instruction in all our training schools.

One very serious difficulty which the Training Institutions have had to contend with, and one really of a serious nature, has been the small amount of knowledge possessed by the candidates at the time of their admission; this is in general so great, that it is a thing totally impossible to make anything of them in less than two or three years: but when once they can draw their supplies from the best pupil-teachers in our elementary schools, a very different state of things will commence; they will then be supplied with young men and young women of eighteen or nineteen, who will have a much greater knowledge of teaching, and of the subjects in which they are expected to teach, at the time of their admission, than many of those, who had been trained there, had after a residence of two or three years in the institution; and instead of three years, it will be quite unnecessary that any of them should remain more than one. Until lately I was of opinion that the Training Institutions were slow in making their usefulness felt in the country; but having had an opportunity of judging of the kind of materials they had to work upon (whether this may not in some measure be the fault of those who recommend I do not know), I feel confident, if sent out at the end of one year's training, the majority of them could not possibly be qualified for schools even of the lowest class, and this without any blame attaching to the teaching in the institution itself.

The system of pupil-teachers, if carried out as it ought to be, and with due vigilance on the part of the inspectors, is admirably calculated for a future supply of efficient teachers, and will in a few years entirely alter the character of elementary teaching throughout the country; on this, as well as on every other account, the standard of acquirements ought not to be lowered.

The reader will find in an Appendix a few short extracts from

an interesting 'Educational Tour in Prussia and Holland,' by an American, Mr. Mann, Secretary to the Board of Education at Boston; they relate chiefly to the importance of the schoolmaster having a knowledge of drawing.

This, it seems, in the Prussian Schools, is almost universal; and the various ways in which a teacher will find it useful, and not only that, but in which, by means of the black-board, it will give life to his teaching, make it a thing of great importance, and one which every schoolmaster, having the slightest taste for, ought to cultivate.*

The reception which a former edition of this little work has met with, leads me to think it has been found useful for the purposes for which it was intended; and I hope the present one, with the additions which have been made, will not be less so, and that the remarks on the effect of the kind of education I am advocating, and its success here, may interest those who are friends to an improved social condition of the middle and labouring classes, and are anxious to bind these two adjoining links of society together by stronger fastenings than hold them at present, although they may not be actually engaged in the business of teaching; but, above all, should every friend to education feel, if he wishes to promote it, that the mass of society never can understand, or take an interest in it, from mere written theories, and can only be brought to do so step by step, and that by a slow progress, by its being brought practically home to them;—it is only in this way that the labouring classes can be made what they ought to be, and what we ought to endeavour to make them.

KING'S SOMBORNE; *April*, 1848.

The occasion of a new Edition affords an opportunity of making a few additional remarks, which, it is to be hoped, may not be without interest.

That schools should be able to get the best elementary books at a cheap price, is a thing of the utmost importance, and although

* The same writer, who clearly does not admire the ordinary way of teaching the alphabet, gives the following anecdote taken from an American prize essay on Education:

"A Mr. Ottiwell Wood, at a late trial in Lancashire, England, giving his name to the court, the judge said, 'Pray, Mr. Wood, how do you spell your name?' To which the witness replied: 'O double T, I double U, E double L, double U, double O, D.' The learned judge at first laid down his pen in astonishment; and then, after making two or three unsuccessful attempts, declared he was unable to record it."

the plan of the Committee of Council on Education for effecting this is not, in its present state, all that one could wish it to be, yet it is to be hoped that the office will, as it gains experience, free it from those crippling conditions which make it objectionable, and which must damage the amount of good that would otherwise arise from it.

The principle of the regulations under which books are supplied, appears to be one having a downward tendency rather than an upward one; inasmuch as it is based on this—that no school belonging to the class with which the Council on Education have to do, can, by a possibility, be in a position to buy its own books at the reduced prices; and in order to be able to purchase, it is made compulsory to ask a grant in aid, limited in amount by the number of scholars: after which it is allowed to purchase to a certain extent, and applications may now be renewed for books and maps at the reduced prices, once a year, to an amount of not less than three pounds: a great improvement upon the first plan; the books forming a grant to be the property of the school, and lent to the children—the others allowed to be sold at the price of purchase.

Now, it surely would have been better to have made the system of buying books at the reduced prices the prominent feature of the regulation, and to have spoken of this as the pith of the matter: the grants in aid to be had recourse to in cases of such schools as are absolutely unable to purchase; making these the exceptional cases, as they ought on sound principles to have been, and not the rule, as it stands at present.

There are no doubt many schools where this grant in aid may be necessary; but there are hundreds of others rising up which, on principle, would prefer buying the books at the reduced prices, if allowed to apply at reasonable intervals; unless this making a grant absolutely necessary should suggest to them the worst of two plans—"facilis descensus averni"—and prove to be a bait too tempting to be resisted.

The parents of the labouring class will naturally, from ignorance, prefer the lending system; and those connected with the management of schools, who have not had experience of the benefits of a contrary one, or perhaps who may not have thought much upon the subject at all, will, from an apparent saving of expense which it holds out, be led to adopt the same.

It never occurred to me as possible, that an application for books at the reduced prices on the part of any school, and without asking a grant in aid, would not be received at the Council office even with some degree of satisfaction—a sort of joy at finding a state of things sufficiently prosperous to enable it to buy books without asking for a grant, and without putting the office to any expense beyond the

mere agency—so that the receiving an answer from the secretary, that the office could not dispense with the preliminary condition of asking a grant, was a matter of surprise—and it has been to me ever since a source of wonder, how so strange a principle should have found its way into practice, more particularly as an example had been set by the National Board in Ireland, which had been for some years furnishing their books to schools of a like class in this country, at low prices, and to an extent limited only by the wants of the school.

Another* thing which ought to be borne in mind, in trying to give a wholesome direction to the education of the masses of a country, is to do it upon principles as little pauperising as possible —and I feel persuaded that a child educated from borrowed books, the property of the school, and one educated from its parents buying them, and their being the property of the child, in a social sense, and for all the economic purposes of life, the two are not the same beings;—nor is the effect on the parents, or the interest they take in their children, the same in the two cases; the minds of the children are not formed in the same mould, nor are they habituated to view things, connected with the way in which they are to struggle through life, through the same medium.

No one, unless he has had experience of children in the matter of education in schools of this kind, can form an idea of the wish they have to possess books of their own, when once they have been interested in what they are learning; and if there is any one thing which more than another, from experience here, I feel entitled to recommend to managers of schools, and to those who take an interest in them, it is by all means to introduce the plan of children

* The exclusively eleemosynary character which many attempt to give to the education of the labouring classes, is, in some respects, to be regretted. One cannot but admire the conduct of those who are at great expense in doing this entirely gratis, in their own localities; still I conceive much greater good would result by establishing moderate payments even in such cases, and any saving from this might be given to school building when pecuniary assistance is wanted. This making them pay, many, more particularly ladies, who have schools of this kind, will not hear of: they no doubt find great gratification and are pleased in doing so much good, but why not allow the parents to join in this feeling, by doing something towards it themselves; without this it excites but little interest in them, and altogether wants that kind of vitality which leads to the best results.

I am persuaded with respect to my own profession, that if we relied more on improving the staple of education in our schools, and less on charity sermons, we should find better and less expensive results. The changes lately adopted in the examinations at Cambridge, and it is to be hoped Oxford may do the same, will eventually, through the clergy, have a most beneficial effect on the education of the labouring and middle classes.

buying their own; a thing which, when once established and the instruction good, there is no difficulty whatever in maintaining.

The prices of these books in the Council list are so reasonable, that the great majority of schools would be able to purchase them; and there could be no greater boon to the cause of education than enabling them to do so (unrestricted by the present conditions), and to an extent limited only by their wants, and allowed also to apply for them at reasonable intervals. The dividing the list into two parts might be worthy of consideration: one of school-books used in the school, from which grants in aid, when necessary, might be made; the other, of books of a more advanced kind for pupil-teachers and masters, and to be had only at the reduced prices.

The putting in circulation a well-selected list of educational books is in itself good, inasmuch as it brings before the school-managers and school-teachers the best books of the kind, which otherwise they might not have an opportunity of knowing much about; and in this way places the education of the country in a wholesome channel, so far as books are concerned.

The restrictions with which the Council regulations are fettered may probably in some measure arise, from the booksellers and publishers being averse to this mode of supplying our elementary schools, and, of course, it is not to be expected that they can sell books at a price which is not remunerating; but if they would consider, that this is not taking away a market, which they have already had, but is opening out one in a quarter which never existed before—(the little which was wanted being supplied by the Christian Knowledge, or similar Societies)—one which, when the people are fairly in a train of being educated, so as to enable them to read when they leave school, will be of an extensive kind. If the publishers would look forward in this way, they would be anxious to supply such schools at prices which may be remunerating to the publisher, although not to the retail trade; the latter would very soon find the benefit of this, as there is scarcely a cottage into which books, bought after leaving school, to a greater or less extent, would not find their way, when once a people are fairly educated.

The supplying our schools with educational books of the highest character, and at the lowest prices, is no doubt a great national object,—one which well merits, and will, it is to be hoped, meet with every attention from the Committee of Council; but whether this can be best effected by the Council endeavouring to put into effective operation the talent of the country, in writing books in all those departments of knowledge which it is desirable to introduce into our schools, and be their own publishers; or whether it can best be done through private publishers and the booksellers themselves, may be a matter of question. The prices at which the

National Board in Ireland supply what are termed poor schools in this country, being a remunerating one, is encouraging to the former plan,—and the increasing demand for books once well established, would enable the bookseller to do it at a small rate of profit; but, under all circumstances, what the country may reasonably expect from the Committe of Council, is—school-books, good and cheap.

Whenever an important want has shown itself in this country, and one by which society would be largely benefited, it is astonishing how much private individuals have done to supply the want; and now that attention is so much turned towards education, as an instrument of great public good, perhaps it may occur to some benevolent individual, blessed with the power to do it, and wishing to connect his name with the education of his country, to appropriate (as the late Earl of Bridgewater did for a high moral purpose) a sum of eight or ten thousand pounds, as prizes for the best educational books, on all useful subjects—appointing some discreet mode of carrying the object out—the copyright to rest with the Committee of Council, in order to render the books as cheap as possible. Such a sum, spent in this way, might largely benefit a whole nation, and would do more to promote the education of it, than any other conceivable application of the same amount of money.

The mode in which benevolent individuals have endeavoured to promote local education, has been by leaving property in the hands of trustees (in many cases the parish officers), and attaching some condition—such as that a certain number of children or the whole of the children of the poor shall be sent free; but however well endowments may have operated in Scotland (and in many instances, also, in the north of England), where, from experience of the benefit of it, a strong feeling in favour of education pervades all classes of society, and where they mix and blend harmoniously together at school, yet in this country, in the rural districts more particularly, where such endowments exist, they have become, in nine cases out of ten, a positive hinderance, rather than a benefit, to the object they were intended to promote. This indifference as to the way in which charitable endowments for education are administered, arises from an entire want of a practical knowledge, that a people can in any way be benefited by it; and it is most strange, that the abuses of these charities in England should not be looked into.

In some counties in Scotland, such bequests have been so large, that the salary of the master has been very considerably increased, in almost every parochial school in the county, and this chiefly owing to the generosity of individuals, who felt that their success in life was owing to an education received at the parish school, and who had a confidence that those intended to be benefited were sufficiently alive to the humanising effects of education upon their children, to see that bequests so left, would be properly administered.

With respect to apparatus of a philosophical kind, it will be found advisable to commence with absolutely necessary things, and to add to these, as the wants of the school in this way make themselves felt; otherwise, the buying expensive things at first, and afterwards, not turning them to account, might lead to disappointment.

Mr. Moseley, in his Report of last year, calls the attention of schoolmasters to a most important subject—one, not less important to their own happiness and welfare, and to that of their families, than it is to the interests of education in general—"the consideration of means for providing for support in time of sickness and of old age, and of contributing towards the maintenance of a family in case of death;" he adds, "that a mutual assurance or benefit society, formed upon a secure basis, among persons of this class, and conducted under the auspices of the Council on Education, would be an inestimable benefit."

This is a question in which the public are deeply interested, as affording the only means of protection against a master continuing to hold his situation, when, from age and infirmity, he is unfit for the duties of it; and school-managers will find some plan of this kind the only security against incompetent teachers, who have become so, from being advanced in life, and whom it would be cruel and unjust to deprive of their situations, unless they had some provision to fall back upon.

It should be the object and fundamental principle of such a plan, that every schoolmaster should be his own insurer;—to secure a provision, for instance, of from 20*l*. to 30*l*. per annum, to commence at the age of fifty or fifty-five; there would be no reason whatever, when a master is competent to his duty, that he should give up his situation when he came into possession of his annuity, but it would be in the power of the managers to prevail upon him to retire, when unfit for it, and it would also be desirable in such a plan of assurance, that the insurer should be able, in case of death before coming into the enjoyment of the annuity, to dispose, by will, of the amounts of payments made; in this way, without being very complicated, it would be something of a provision for those dependent upon him.

In a well-digested plan of this kind, all the good schoolmasters would insure; this would have the effect of retaining them in their employment, many of whom would otherwise leave it; and, in many ways, the plan seems to be so important to the cause of education, and, in fact, so necessary to its ultimate success, as to make it well deserving the consideration of those, who have the power to carry it out; and the public have so great an interest in it, that the Committee of Council may reasonably be expected to give some assistance towards doing so; grounded on the principle of every man

being his own insurer, no Chancellor of the Exchequer could possibly object. This ought not to interfere with any consideration, by way of reward, to those who, from great success in their vocations, and from long service, might be thought worthy of them—but it might be a part of the plan, to make some addition to an annuity, in cases of merit of a high order, in this hard-working department of the public service.*

In a letter published some years ago, as an appendix to Mr. Allen's (now Archdeacon Allen) Report, I alluded to Lord Howick, the present Earl Grey, having suggested in the House of Commons, "voluntary examination of the schools in a district," and his having pointed out to the minister "that further encouragement might be given by occasionally conferring, on the deserving, situations in the lower ranks of the public service." Sir Robert Peel, in answer, expressed "as his only fear, that children did not remain at these schools to a sufficient age to be fit for them," but otherwise seemed to receive the hint remarkably well.

It is rather singular, that the friends of education in the House of Commons, should have allowed this hint thrown out by Lord Grey so completely to drop, as it seems to have done, and I fear since his lordship has been in office, and has had the power of acting upon it, that he also may have forgotten it—at least one has never seen mention made since, of this kind of encouragement in the speeches of either House of Parliament; so that this may only have been one of those things thrown out when in opposition, and having an appearance of good intention, but where there was not sufficient earnestness of purpose on the part of the speaker, to carry it out, and take the responsibility of doing so when in power; however, be this as it may, there can be no doubt that if such encouragement is held out, and if an educational test were established throughout what is termed "the lower ranks of the public service," or if carried farther, and any system adopted of selecting from the schools in which this class of society are educated, those best fitted by education or by character for such situations, that many boys would be found to remain; and not only that, but that they must be found to be well qualified for them. Many, if this principle of selection were adopted, and who find their way into the very situations in question on easier terms, would remain longer at school; and thus a wholesome channel for supplying this part of the public service would be opened out, by which the public would be benefited

* The fact of its being alluded to by Mr. Moseley, in his Report, was the cause of a memorial being sent to the Committee of Council on the subject, signed by 84 schoolmasters in that part of the north which is under Mr. Watkin's inspection alone—a strong proof of the importance which the masters themselves attach to such a plan.

in getting those best qualified to serve them.* There is a class in our rural districts, that just above the labourer, who would find great encouragement in this, but who from being, as it were, above daily labour, and finding nothing to do, are worse educated, and in every way worse brought up, than any other class in society; this would hold out to some a road to useful employment, and many of these youths when educated in this way might find most useful employment in our colonies; why should not these sources be to them what India is to the classes above them?

But although the subject of establishing an educational test, in the kind of offices above alluded to, does not seem to attract the attention of statesmen on the ground of the principle which it involves, or of its public importance, yet it has, I am happy to say, suggested itself in one quarter, when there is the power to act upon it, from a conviction of the good which it will do; at the same time being a means of finding for the public service, in such departments, those best qualified for the duties of it.

About a year ago the chairman of the now Inland Revenue Board, who is in no way connected with this part of the country, and to whom I was at that time an entire stranger, offered in the kindest way to place at my disposal, for the encouragement of education here, the first situation in the Excise which he had to give, wishing it to be given to the one who, all things considered, was the best qualified for it, and it is to be hoped so good an example may find others ready to follow it.

This mode of appointment, founded on merit, has a great advantage over any other; it is based upon the highest and best principles, and would, if extensively acted upon, lead to a most important change, in what may be called the *morale* of the lower departments of the public service.

The minister who would endeavour to introduce an educational test in all cases of this kind, and do his utmost to carry it out, would deserve well of his country; he would at the same time that he was indirectly promoting the best interests of society, have the satisfaction of feeling that he was filling up such situations, with those most competent for the duties of them.

It is now beginning to be generally felt, that the only way to make our national and similar schools efficient, and to have them remaining so, is by making them places of education, not exclusively for the labouring classes, but by having the standard of acquirement and the means of carrying it out, such as are fitted for the wants

* At present such situations fall too much to the lot of the sons of those having the franchise in borough towns, by no means the class of society best fitted for them.

of all the industrial part of the community located in a district. This, both from experience and from the nature of the case, is now becoming evident, and a strong evidence is given of it in the number of schools of this kind now rising up in different parts of the country, and taken up by influential individuals in a way which gives every promise of success.

The way in which we have lately seen Sir Robert Peel reorganising the school at Tamworth, and the evident interest which he takes in doing so, show clearly what his opinions are as to the mode in which the education of the country ought to be carried out, and the practical bearing which it ought to have upon the employments of after life; and it is greatly to be wished that a man of his acknowledged talent as a statesman would not confine his interest in it to his own locality, but that he would, as a public man, give that consideration and assistance to the cause of education, which, from his position, he is so well able to do; and which, from the importance of the question, in its bearings both upon our own social relations at home and in our colonies, it so well deserves.

At a meeting in Staffordshire a few months ago, at which Lord Harrowby presided, the general feeling seemed to be of the same kind. The following is an extract from the reported speech of the chairman:

"It was pretty evident that in many parts of the country the poorer classes were placed, as regarded education, in a better position than those immediately above them; that the labourer's children were, in fact, in the way of being better educated than those of the farmers, and that this arose from the fact that the state assisted the former, whilst the latter were entirely neglected. Those connected with farming were no doubt generally able to give their children a suitable education; but they were so divided by distance of residence and so unaccustomed to combine, that they were placed in a very disadvantageous position as compared with the inhabitants of towns. In general, the sons of farmers were sent out to school at a cost of from £25 to £30 per annum, and the expense, when there was a number of sons, was so great, that the youths were often removed before their education was completed. To remedy this evil two plans have been suggested: the first was to establish new and independent schools, and the second was to improve the common schools scattered over the country. The objection to the first of these plans was the expense, and the great uncertainty of the result; whilst to the second was urged the unwillingness of farmers to allow their children to mix with the children of the humbler classes. He, however, did not see that the entertainment of the one scheme should preclude the consideration of the other, and that the meeting should appoint a committee to consider the subject. *Experience* had justified the establishment of schools in which all

classes mixed for the purpose of education; and the High School of Edinburgh might be pointed out as a worthy example, where the high and the low, the son of the peer and the son of the artisan, studied under the same roof, to the advantage of both. The mixture of the various orders of society in a common school, while it did not deteriorate the morals and manners of the pupils, induced the cultivation of kind and social feelings."

In fact, the whole of Scotland is an example of this. With respect to the observation of Lord Harrowby, "that the farmers are left to themselves," they in fact want no assistance; all that is wanted on their part is the common sense to see that the only way in which they can, as a class, be properly educated, is by making our parish schools efficient for the purpose, and by their getting rid of their prejudices, and sending their children to them.

Earl Talbot, the Bishop of Lichfield, and others, expressed themselves to the same purpose; and Mr. Adderley, member for the county, added, "that he considered the plan of adopting separate schools hopeless, and thought that of improving the character of the national schools by far the most feasible. He should object, however, to any plan which gave a boon to the farmers and middle classes at the expense of the labouring classes."

So far from establishing mixed schools being a boon to the farmers and middle classes at the expense of the labouring classes, I believe they will have a decidedly contrary effect, and that the establishing separate ones for sons of farmers, &c., would be in every way detrimental in the end, and bring about such a state of things in the schools exclusively for the poor, that in a very short time the character of such schools would be in no way better than it has been, and that as places of education they would entirely fail.

One resolution of the meeting, proposed by the Bishop of Lichfield, was, that it was expedient to provide from the training schools or institutions at Battersea,* fit and proper masters for the

* This institution owes its origin, and for many years nearly its whole support, to Mr. Kay Shuttleworth and Mr. Edward Tufnell, and in 1842 was transferred to the National Society.

The Rev. Thomas Jackson, the principal, has lately printed a statement of its views and prospective objects, to which is appended testimonials of the masters and condition of the schools to which the Battersea masters have been sent.

These statements afford a very gratifying proof and are strong evidence of the good which must result from establishments of this kind, conducted as Battersea is. The education of the country must necessarily and in a great measure take its tone, and assume its character of usefulness, from the sources from which the teachers are derived; and if the opinion of one who has paid considerable attention to the educational wants of the present

National schools, and that those masters should be qualified to communicate religious instruction and teach arithmetic, geography, the lower mathematics, and the sciences applicable to agriculture; and I believe they have since sent six young men to the Institution there for the purpose of being educated as masters.

In the present transition state of the country as to education, such meetings have a more than ordinary interest attaching to them—in fact at this moment in some measure a national one—as much depends upon what is done in the next few years, as to the direction which the education of the country will take,—a question of no small importance to the rising generation, although one, to which many of the present are perfectly indifferent.

time, and the way in which those wants can best be supplied, were likely to be of any weight, he would strongly recommend Battersea and similar institutions to those who have the means and the wish to aid the cause of national education. Much more good, in an educational point of view, is likely to arise from bequests and from gifts to institutions of this kind under efficient public control, than in any other way; and it is greatly to be hoped that the efficiency of good training institutions, both for schoolmasters and schoolmistresses, may not be checked for want of means.

KING'S SOMBORNE;
April 7, 1849.

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SUGGESTIVE HINTS.

HAVING taken a considerable interest for some years in the daily teaching of my own village school, I am, from the success which has attended it, induced to offer the following outline of what is taught, and the manner of teaching it, to the attention of teachers in our elementary schools,—as being likely to be of some assistance, at all events to the less experienced among them, and perhaps not altogether useless to those whose qualifications and training in our Normal Schools may have better fitted them for their work.

And first, it is of great importance that the teacher should be able to interest the children in what they are doing; and this, if he takes a lively interest in it himself, he will find no difficulty in, even when teaching what is looked upon as the mechanical part of reading; particularly if he knows how to mix with it a little oral instruction of a conversational kind, and has any judgment in selecting subjects to talk to them about,—such as the domestic animals, birds, &c., and other things, with which they are brought in contact in their earliest years—the cat and dog, how they differ in their habits, manner of living, and how useful to man,—the one attaching itself to places, the other to man; then perhaps relating some short and amusing anecdote of the dog or other animal, for which a good teacher would be at no loss, and would always see, if he has any tact, from the countenances of the children, whether he was interesting them or not, and would go on, or leave off, accordingly.

And again, if a cow or horse is mentioned—drawing them into a description of it—a child will perhaps say, a cow is a four-footed animal. Teacher: yes, but so is a horse; and then will point out something in which they differ. The child will then try again—a cow has got horns, but a horse has not; then the teacher will point out that some cows have no horns,

and will lead them on into things, in which the cow and horse really do differ—such as the hoof: the cow having a cloven foot with two hoofs on one foot; what other animals have the same?—difference in the way of feeding; a cow chews the cud—ruminating: does the horse?—what animals do? sheep, deer, &c. What difference in their teeth; has a cow front teeth in the upper jaw? a sheep? a horse? &c. What do you call a number of cows together? what of sheep?—of deer?—of swine?—of bees? What are the habits of animals going many together? mention those you know which do so. The flesh of the sheep called what?—of the ox? The particular noise of the sheep, cow, horse, swine, &c.? bleats, bellows, grunts. The young of a cow? a calf;—and its flesh? veal. The young of the horse, what? a foal. Spell calf, calves: write them down on your slates. And in this way children may be led into a tolerably correct idea of the thing in question, and will be partly able to describe it themselves; all this they tell again at home, which has its use.

There is something extremely pleasing and interesting to children in having their attention called to the habits—difference in structure—in covering—in manner of feeding—in fact, all possible outward differences, a knowledge of which can be acquired by the eyes and by the hands (seeing and feeling) of the beasts and birds about them; and of this a very strong proof is given, in what I have related in connection with my giving to a class of boys a lesson of the following kind, which was suggested by some observations in a book on Natural History, by the Rev. L. Jenyns, on the difference of the way in which animals with which they are acquainted rise. How does the cow get up?—hind-feet or fore-feet first? how the sheep? how the deer, &c.? Some will answer right, some wrong, but all think and are alive to the question. Then pointing out to them, that all these animals rise with the hind-legs first, and that they belong to the class of ruminating or cud-chewing animals—and, that if it is true that in one, two, three, four, &c., particular cases of animals which chew the cud, that they rise in this way; whether it would not be likely to be true in all cases—showing them the way of getting at a general rule, from its being true in a number of individual instances.

Then again: How does the horse, the pig, the dog, &c., rise? hind-feet or fore-feet first? do they ruminate? have they

front teeth in the upper jaw? The teacher would point out how they differ from the ox, the sheep, &c.

Children living in the country are very much alive to this kind of instruction, and I found that several of them in going home from school had observed the animals when rising, and gone out of their way to make them get up; thus bringing to the test of experience what they had been taught, and commencing, at this early period, habits of observation on things around them; which, in after life, may add much to their happiness, and open out sources of enjoyment to them, to which they have hitherto been strangers.

Happening to mention that some observers of the habits of animals thought that sheep more frequently lie down on the left side than the right, I find that many of them count a flock of sheep, as to the side they are laying on, when they see them lying down in the fold or in the field; and I have no doubt will, in time, have counted such numbers as may balance their opinions one way or the other.

Mr. Jenyns says, that he mentioned to a farmer, who had passed all his life among animals belonging to the farm, this difference in the mode of rising in the horse and in the ox—the sheep and the pig—and generally in the cud-chewing and non-cud-chewing animals, but that he (the farmer) was not aware of it; and I recollect myself many years ago in college combination-room, a conversation arising as to whether a sheep had a double row of teeth in front, similar to the horse (and in the same way the cow), when, strange to say, although every one seemed to know that it was the case with the *horse*, yet not more than one or two were aware that the sheep had not; and so many doubts were started about it, that two young men of the party walked a considerable distance to a field where there were some sheep, and caught one of them in order to examine it.

When able to read with tolerable ease, and when they have acquired some idea of reckoning up small numbers, which they very soon do, it will be found extremely useful occasionally to call their attention to the number of letters in a word—pointing out which are vowels, and which are consonants; for instance, the word *number*—how many letters? six. How many are vowels? two. Then how many consonants: some will reckon by looking at the book; others, and these are the sharp ones, will reason and say, as there are six letters, and

two of them vowels, the remaining four must be consonants; making it a question in arithmetic.

In this way very great interest may be excited; and when such words as *bounty*, *city*, *yearly* occur, the teacher should point out, that at the end of words *y* is a vowel; at the beginning, a consonant; and then ask them to quote all the words they know beginning or ending with *y*: this gives them great facility in acquiring words; such questions, as, what is the first letter in such and such a word—what is the last—how many syllables in the word—what is the middle syllable—what is a syllable made up of? of letters. What is a word made up of? of syllable or syllables. This interests much more than the ordinary way of reading without observation, and keeps up the attention.

Again, call their attention to the page of their book—say it is page ten, eleven, twelve, or thirteen—how many leaves? five, five and a half, six, six and a half; and from this they will very soon gather that when the page is denoted by an even number there is an exact number of leaves, and no odd page remaining; hence the teacher will point out to them, that all even numbers are divisible by two without a remainder, and that an odd number, when divided by two, always leaves a remainder of one. Occasionally making them reckon the leaves, in order to show that it agrees with their arithmetic, is good; in fact, there are innumerable ways in which the common sense of a teacher ought to be called forth.

It will also be useful to give them correct ideas of the kind suggested by the following questions: Where does the sun rise? point in the direction. Where is he at noon? Where does he set? When is he highest in the heavens? In what direction is your shadow cast in the morning: in what direction at noon?—in the evening? In what direction do you come to school?—go home? and as they come, of course, from very different directions, this becomes more instructive. Point to your home—towards sunset. Are the days lengthening or shortening? Will to-morrow be longer or shorter than to-day? In what direction is such and such a parish or striking object? How the parish in which they live is bounded on the different sides, &c. In this way children may be made to get correct ideas as to east, west, north, and south, and the intermediate points.

The teacher should also occasionally call one of them forward, and, putting a piece of chalk into his hand, tell him to draw a line on the floor running north and south. What is the first letter of north, and what of south? put N and S then at the proper ends; how does he know the south from the north? draw a line through the middle running east and west—another half way between the east and the north—the east and the south, &c. This they are all pleased in being able to do themselves, and there is scarcely a boy in the smaller classes that would not do it with great accuracy; of course the teacher might vary it, by telling a boy to begin and make a ring (circle) on the floor as if he were going to play marbles, then to draw a line through the centre due east and west—another north and south, and this way has an advantage; as they improve in doing it, they will get to something like the figure of the compass.

I have observed also, that they take great interest in having their attention drawn to the particular points in which the sun rises and sets; for instance, that on a certain day in March he rises due east and sets due west; that every succeeding day up to the 21st of June he rises farther and farther to the north of east, and sets a little farther to the north of west, on each succeeding day, and up to this point the days go on increasing; he then returns in the same way, rising nearer to the east and setting nearer to the west on each succeeding day until the 21st of September, when he again rises due east and sets due west: then up to the 21st of December rises farther to the south of east and sets farther to the south of west, and on each succeeding day describing a smaller and smaller arch in the heavens and the days shortening.

This becomes a matter of daily observation, as a thing which they can see with their own eyes, and interests them accordingly.

Again, the teacher should point out how their shadow is longest when the sun is in the horizon—diminishes up to noon, when the sun is highest, and then increases again until sunset—what it would be if the sun were over their heads, &c.

The following verse, from one of the Lessons, affords considerable instruction:

"Trudging as the ploughmen go
(To the smoking hamlet bound);
Giant-like the shadows grow,
Lengthen'd o'er the level ground."

Questions like the following are also instructive. If the sun rise at five o'clock, half-past four, three, &c., in the morning, at what time will he set? getting them to understand what mid-day means, and that there are as many hours from sunrise to noon, as from noon to sunset—that the difference between the hour of rising and twelve o'clock will give the hour at which he sets.

As soon as children are able, the teacher should endeavour to give them correct ideas of the measures of time, of space, and of volume: ask them, for instance, What is a year? they will answer, twelve months. What is a month? four weeks. What is a week? seven days. What is a day? twenty-four hours. What is an hour? sixty minutes: and thus driving them into a corner, they find out the answer was not the one expected, and begin to think on the subject: the teacher should then point out to them, that a year is a measure of time, as a yard is a measure of length; that a month, a week, a day, &c., are also measures of time, but of less duration than the year; of course they will afterwards be made to understand what duration of time the year does measure: he should then point out the great conveniences of the subdivisions of time for the purposes of civil life.

I was pleased some time ago in going into the school, to see the contrivances of some of them in making a clock-face on paper, which had been the evening task for one of the lower classes; what struck me was, the great regularity of an inner and outer circle for the face, in many instances as if made with compasses; they had had recourse to cups or saucers, or any other circular things of unequal dimensions in their cottages, but of a size which came within the compass of their paper on which they placed them, and then run the pen round the edges; this shows that man is a contriving animal, and I have no doubt the task afforded amusement and instruction both to parent and child.

The teacher should exercise the children on the clock-face, pointing out that the minute-hand goes round twelve times for the hour-hand once; that the circle on the face is divided into twelve equal parts; that while the minute-hand goes once round the whole circle, the hour-hand would only move from twelve to one, or $\frac{1}{12}$th of the whole; that when it had gone twice round, the hour-hand had arrived at two o'clock, or

$\frac{2}{12}$ths; when three times, at three o'clock, or $\frac{3}{12}$ths, and so on; and when the minute-hand had gone twelve times round, the hour-hand would have moved over twelve of these divisions, or $\frac{12}{12}$ths: in this way they by degrees get some idea of fractions.

In the same way as to measures of length, giving them a correct idea as to the length of a yard, a foot, an inch, &c., and how many times the smaller measure is contained in the greater; and here the teacher would do well to have a two-foot rule, and make first one and then another of the children measure the dimensions of the room—the length and breadth of the doorway, or any distance between one fixed point and another—to show them to what particular purposes in civil life these measures are used, measuring the distance between one place and another; that the yard is the measure by which they buy calico, flannel, fustian, cloth, cordage, &c., all things for the purposes of clothing: the length only being measured, the breadth being of a standard kind.

That in speaking of the size of a room, of a garden, of a field, both length and breadth must be taken into account—of a peck, a bushel, a quart, &c., length, breadth, and depth—and the particular things measured by these should be pointed out.

Again, as to weight, the name of all the weights used, from a ton downwards, or from an ounce upwards, speaking to them of the particular things bought at the shop by weight—of those bought by volume—that fluid substances easily taking the shape of the vessel into which they are poured make the usual modes of measuring them the most convenient; that solids, instead of putting them into any particular measure, might be more easily measured by putting them into the form of some regular solid, and then taking its dimensions,* &c.

When a class is able to read without spelling, the teacher should endeavour to interest them in what they are reading, by showing them specimens of anything which may be men-

* A friend of the author's, speaking with a large farmer in his neighbourhood on the importance of giving the agricultural labourer a better education, observed that he thought it very probable there was not one of his labourers, and he employed a great many, who knew the number of ounces in a pound, although they were in the daily habit of buying things by these weights. The farmer could not see much good in education, and thought none of his labourers so ignorant as this; but agreed to ask them the question on the Saturday night, when he paid their wages, and, to his own great astonishment, there was not one who could answer it.

tioned; pointing out whether it is of an animal, a vegetable, or a mineral kind—if a manufactured product, how made, and the nature of the raw material—if it form any part of what they eat, or drink, or wear; how it is called into use in any of their domestic concerns; in the every-day occupations of themselves, or of their parents; connected with the mechanic trades, or with farming occupations; in short, calling their minds into exercise in every way he may have it in his power.

For instance, the pen and ink with which they write? the one animal, the other vegetable matter dissolved in water;—how the water dries away and leaves the vegetable matter behind?—paper made from what, and how?—when first made?—difficulty of getting books before that, and on what written?—printing, when invented?—wooden types, afterwards metal types, &c., down to printing by steam: the slate they use;—the string which fastens it round their necks; the binding of their books, pointing out the variety of materials used, and the trades called into operation in preparing them;—the little woodcuts which illustrate their lessons, how made, &c.

Also in the same way the manufactured articles of ordinary clothing, how made, and whether the raw material is animal or vegetable—leather, how prepared, &c.: their stockings, knit or woven; carding, spinning, knitting.

GRAMMAR.

Grammar is taught here almost entirely through their reading lessons, and in this way, far from being the dry subject many have supposed it to be, it becomes one in which they take great interest. Any attempt by giving them dry definitions of parts of speech and rules of grammar is almost sure to fail; for one which it interests, it will disgust ten, and therefore the thing ought not to be attempted in this way. The most natural and easy manner seems to be, first,—

Pointing out the distinction between vowels, consonants, and diphthongs, from words in their lessons: when *a* or *an* is used before a noun: the difference between *a* table, and *the* table; between a book, and the book; a sheep, and the sheep; a deer, and the deer: whether they would say a house or an house; a hare or an hare; an heir, an hour; drawing attention to exceptions as they occur.

The next and easiest thing would be the nouns, pointing out all the things which they see around them; such as book, table, map, &c.: and thus they immediately know that the names of all visible substances are called nouns. This being once fixed, they are soon led to the idea, that the names of things which they can imagine to exist, are nouns also;—to distinguish the *singular* from the plural: that the singular means *one*, the plural more than one:—the general rule of forming the plural by adding *s*; house, houses; map, maps; &c.; the teacher taking care to point out the exceptions as they are met with in reading, such as ox, oxen; tooth, teeth; man, men; loaf, loaves; church, churches; city, cities; and to observe also, where anything like a general rule can be traced out, such as that nouns ending in *ch* soft make the plural by adding *es*, as church, churches; arch, arches; match, matches; while in *ch* hard they follow the general rule, as monarch, monarchs, &c.; in *sh*, as dish, dishes; fish, fishes, &c., adding *es*; in *f*, as leaf, loaf; changing *f* into *v*, and adding *es*, leaves, loaves; nouns ending in *y* into *ies*, as city, cities; fly, flies; why such words as boy, valley, do not follow the general rule.*

The teacher would do well to exercise them in forming the plural of any particular class of nouns as they occur; for instance, nouns ending in *f*, as leaf; spell it in the plural, leaves; potato, potatoes; negro, negroes; echo, echoes; and making them quote all the nouns ending in *f* and in *o* they could possibly recollect; the same way for others. This calls forth great emulation, and is attended with good results.

The difference of gender, also, in nouns ought to be pointed out, a thing very necessary in this county (Hampshire); everything alive or dead, male or female, coming under the denomination *he*, never by any chance changed into *him*.

They would now be able when sitting down, and without the assistance of a teacher, to pick out all the nouns in a lesson, writing them in columns in the singular and plural number;

* I would strongly recommend to all our school teachers a small book by Professor Sullivan, called 'The Spelling Book Superseded,' on this subject, as well as his other books, 'Geography Generalized,' his 'Geography and History,' and his 'English Grammar,' published by M'Glashan, Dublin, and by Messrs. Longman, in London. They are all excellent in their way, and have done good service here. The difficulty of pronouncing *s* at the end of nouns ending in *ch*, *sh*, and *x*, will show the reason for adding *es*.

also, to write on their slates, or as exercises on paper in the evenings, things of the following kind:

The names of the months in the year, and the number of days in each.

Of all the things in their cottages and in their gardens—of all the tools used by the carpenter, such as plane, axe, chisel, &c.,—by the blacksmith,—of all the implements used in agriculture, or in their trades and occupations.

What are the names of all the tools made of iron which we use in the village?

The names of all the trees—of the vegetable and animal products of the parish—of such vegetables as are food for man, for beast, &c.—of all articles of home consumption, &c.—of the materials of which houses are built, &c.

Describe a dog, cat, barn-door fowl:—write the names of all the singing-birds—of the birds of prey, &c.: write down six names of birds, all of which are compound words.

A year, a month, a week, day, hour, are measures of what?

A yard, a foot, an inch—of what?

A quart, a bushel, &c.—of what?

The teacher might also set each child to write down the date of its birth—to make out how many years, months, weeks, days, &c., old it was; so as to give its age in all the different measures of time.

Being now able to point out the nouns, &c., they should advance to such words as qualify them—adjectives.

The teacher, holding up an apple, for instance, will ask, Do all apples taste alike? No, sir; some are sour and some are sweet, bitter, &c. Do apples differ in any other way? Some are large and some are small—this is differing in size; some are red and some green—this is differing in colour; some soft and some hard—this is differing in the quality of hardness; some are rounder than others—differing in shape; and all these words, expressing different qualities in the noun, are adjectives. Then, perhaps, they are told to sit down and write all the words they can think of, which qualify the word apple, such as sour apple, sweet apple, large apple, &c.

Then to get at the degrees of comparison: The teacher will observe the different sizes of the children, taking two of them out and making them stand side by side. When I say that this boy is taller than the one next to him, what am I com-

paring? The height of the two boys. This boy has got darker hair than the one next him—the colour of their hair: you have got cleaner hands than the boy next to you—the cleanness of my hands with the cleanness of his: such a child is the tallest in the class—is the best reader in the class. What do I compare? His or her height with the height of all the rest; his or her reading, &c. In this way they will very soon understand what is meant by degrees of comparison, and should be told how to form them: tall, taller, tallest; great, greater, greatest, &c.; taking about half-a-dozen adjectives at a time, the children repeating them, and occasionally being set to write them on their slates. Reasoning in this way, the general rule soon strikes them, and the teacher must take care to point out the exceptions. Their very errors in following out a general rule, are sometimes instructive, as well as amusing: for instance, if you give them such a word as *little*, or *good*, they will immediately begin, good, gooder, goodest, following out the general principle; when all at once it flashes across them that the word is an exception, and the sort of knowing look they give you, as if you had tried to take them in, is most amusing.

In monosyllables, such as *hot*, *hotter*, *hottest*; big, bigger, biggest, making them write down words which vary from the rule by doubling the final letter, and pointing out to them, that this is the case with all words of one syllable ending in a consonant, with a vowel going before it.

The teacher should now begin to point out the pronouns as they occur—what particular nouns they stand for in a sentence—what case—whether they mark possession, &c.; for instance, when *I*, *he*, or *she* occurs, to ask them what they make in the objective cases; what in the possessive. If *him* or *them* or *her* occur, what is the form of the nominative; and occasionally using the pronouns in making short sentences, in order to fix a clear impression on their minds: such as, where is my book? I saw it just now: the pen which I had in my hand: the book which he is reading; showing them in this last sentence you cannot understand which is meant by *he*, unless the noun to which it refers has been mentioned before.

With respect to the verbs: in this school they are constantly exercised in going through all the persons and tenses, past and present, both on their slates, and occasionally by having two or three given to bring in writing as an evening

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exercise: showing them they must use the present tense of the verb, or an auxiliary verb with the present particle if they speak of a thing while it is being done—the past form of the verb or the auxiliary verb and past particle, when the action is past: the teacher would write an example on the black board, such as

I work,	We work,
Thou workest,	Ye or you work,
He works,	They work:

present participle, working; *past*, wrought.
I write, &c., writing; written:

particularly pointing out the auxiliary verbs when they occur with a past participle—and noting words where the past form of the verb and the past participle differ—as wrote, written; smote, smitten—calling upon the children to make short sentences to illustrate it: I wrote a letter—a letter was written; he broke a cup—a cup was broken. He should also correct such expressions as I writ a letter—father work for Farmer A—we *works* for Mr. B—we reads—I does, &c. It is interesting to observe how much the school is altering expressions of this kind here: the school-children of any age will all say, my father or father works—we do, we work; or, if from habit they are led into making use of the former mode of expression, they will many of them immediately correct themselves.

This kind of teaching, young as many of them are, seems to exercise their minds, and give them a great interest in what they are learning.

In the same way their attention must be called to all the other parts of speech as they occur.

It is very important that the teacher, in exercising them in these parts of grammar, at first should select words to which they can easily attach ideas; as *nouns* for instance, the names of visible objects, such as ploughs, harrows, horses, cows, &c.; then tea, coffee, sugar, wheat, oats, things connected with their daily occupations, and the qualities of which are known to them; this soon gets them into the way of knowing what an *adjective* is. Again, for *verbs*, select such words as express some action they are in the habit of doing—to walk, to ride, to plough, to harrow—then point out the difference to them, or ask them to explain the difference between *a* plough and *to* plough—*a* harrow and *to* harrow—*a* walk and *to* walk—*a* ride and *to* ride—and that the noun which is in the nomi-

native case is the doer of the action—the verb expresses the doing it, and the noun in the objective case is the thing on which the verb acts.

It will be necessary to point out the inflection of nouns, although the nominative and objective cases are generally the same, in order to show them how this ought to be attended to in the personal pronouns, &c. To notice such expressions as I saw he, I saw she, which they would invariably say here—and how they are wrong. For instance, suppose the teacher gives such a question as the following to write about: What is a spade made of, and what are its uses? he should take care to explain why he uses the pronoun *its*, and get them into the way of using the pronouns properly by making little sentences of their own to illustrate them—how verbs are made into nouns by adding *er*, as do, doer; walk, walker; talk, talker; plough, plougher, &c.—nouns into adjectives by adding *al*, as national, &c.

Compound words may be made very instructive and very amusing to them: bird-cage, pen-knife, &c. The teacher to lead them to explain what a compound word is; if asked, they will answer, perhaps, "A word made of two words;" then show them that this is correct as far as it goes, by mentioning several words made up of two, and ask what they would call a word made up of three words; they immediately see that their definition comes short of what was wanted; then show them that a "word made up of two or more words" would include every case; this speaks to their understanding better than if a correct definition had been given at first.

Pen-knife—*pen* does not explain the material of which the knife is made, but the use to which it is applied.

Oak-table—*oak*, taken as an adjective, explaining of what the table is made; might say oaken-table: writing-table; made up of a noun, table, and a participle, explaining for what the table is used.

Bring, to-morrow morning, neatly written, six compound nouns, names of things about your houses. They will probably bring such as fire-side, bed-post, house-door, tea-pot, sugar-basin, milk-pail. In the morning the class to be arranged according as they have done; the teacher to interest them by showing how the meaning of the compound words is to be got at through the simple ones.

The word barge-river is invariably used here for canal; I doubt very much whether many of them know what is meant by canal.

The importance of making the instruction turn a good deal upon their own occupations and domestic consumption, can scarcely be overrated; it leads to a fire-side conversation in an evening, between parents and children, of a most interesting kind; and by setting the children questions of this kind for an evening exercise the whole family is set to work.

The reading-books used here are principally those published by the Irish National Board, numbered 1, 2, 3, 4, 5, and those of Professor Sullivan, in connection with it; a list of them is given at the end.

The following specimen from an easy lesson may be taken as a mode of teaching: (*Second Book of Lessons*, page 49.)

"We cannot but admire the way in which little birds build their nests and take care of their offspring. It is easy to conceive that small things keep heat a shorter time than those that are large. The eggs of small birds," &c.

Point out the vowels in the first line—the consonants in the word *build*—what is *ui?* a diphthong, and build pronounced like *bild*. What is a bird? a thing. A *nest?* a thing. And therefore what parts of speech? nouns. *Birds*, does that mean one or more than one? More than one. What do you say when you mean only one? A bird, a nest. When only one, what number is that? Singular. When more than one? Plural. You say a bird, a nest; would you say *a egg?* No, sir, *an* egg; *a* before a consonant, *an* before a vowel. What are *a* and *an?* Articles. *Cannot but*, what does that mean? Must admire—be much pleased with. The teacher will point out that, if speaking in the singular number, the sentence would be: *We cannot but admire the way in which a little bird builds its nest and takes care of its offspring.* Then the class will sit down and occupy themselves in writing on their slates all the nouns in the lesson.

The pieces of poetry they learn by heart, having first made each piece the object of one or two reading lessons; they then write down from memory, either on their slates or as an exercise on paper, about half of one of the short pieces at a time; at first they will run all the lines together, perhaps, as in prose, or begin the lines with small letters,—write *i* for the pronoun

I, and so on; but in a very short time they write them out most correctly, and this exercise is a very useful one.

Again, (*Lesson Book*, No. 3, page 230.)

"ON HUMAN FRAILTY.

"Weak and irresolute is man,
The purpose of to-day,
Woven with pains into his plan,
To-morrow rends away.

"The bow well bent, and smart the spring,
Vice seems already slain;
But passion rudely snaps the string,
And it revives again."

Weak and irresolute; what parts of speech? Adjectives. What word do they qualify? Man. What does the prefix *ir* mean? Not. Can you quote any other words with the same prefix meaning *not?* Irregular, irreparable, &c. *Is;* what part of speech? An auxiliary verb. In what way does it differ from *have*, as to the case which comes after it? It always takes the nominative case both before and after it; it was I, it was he whom I saw;—*have* follows the general rule. *Woven;* what part of speech? Past participle from weave. Are the past participle and the past tense of this verb the same? No, sir; wove, I wove, thou wovest, he wove, &c. What are the warp and woof in weaving? The *warp*, the threads that run the long way of the cloth; and the *woof*, the threads that run across: the woof is thrown by the shuttle over and above each alternate thread. Do you recollect any piece of poetry which you have learnt in which *Time* is called the *warp* of life? Yes, sir. Quote it.

"Time is the warp of life:—Oh! tell
The young, the fair, the gay, to weave it well."

What is meant by Time being the warp of life? The length of life. What by weave it well? Spend it well. *With pains*, means what? With trouble. *His plan; his*, what part of speech? Relative pronoun, referring to man; possessive case of *he;* the objective, *him*. In the second verse, *rudely snaps;* what part of speech is rudely? An adverb explaining the way in which the action of the verb is performed. *Slain*, what part of the verb?

The class will then sit down, and write in their own words,

the substance of what the first two verses have conveyed to their minds, or perhaps of one verse; afterwards get it by heart, and, as an evening exercise, bring it written from memory on paper. It is a great thing if the teacher can get them to write out in their own words at all correctly, the sense conveyed to their minds of a sentence in prose or verse.

In teaching a lesson, such as the following two verses from *Lesson Book*, No. 3.

> " Thus far on life's perplexing path,
>   Thus far the Lord our steps hath led,
> Safe from the world's pursuing wrath,
>   Unharm'd though floods hung o'er our head;
> Here then we pause, look back, adore,
> Like ransom'd Israel from the shore.
>
> " Strangers and pilgrims here below,
>   As all our fathers in their day,
> We to a land of promise go,
>   Lord, by thine own appointed way,
> Still guide, illumine, cheer our flight,
> In cloud by day, in fire by night."

After explaining the first two lines, the teacher asks perhaps the grammar of a part of it, but from the words not coming in the prose order the children find a difficulty; he should, therefore, read them, thus — The Lord hath led our steps, thus far, on the perplexing path of life; and they will at once get at the grammar of it, as well as the meaning; *safe*—what part of speech, and what word does it agree with? The verb from the same root is what? save: and the noun? safety. What does the fourth line mean? does it mean that waters are suspended over our heads? And then read to them the plain meaning of the lines in something like the following words:

The Lord hath led our steps, thus far, on the troublesome path of life; protecting us from the pursuing wrath of the world uninjured, notwithstanding dangers have surrounded us: here, then, we stop, we review the past, we thank God for his protection from danger, as the Israelites did when they found themselves set free from the Egyptians and on the other side of the Red Sea.

We, Lord, as strangers and pilgrims in this world, go, in the way in which thou hast appointed, to a land of promise, in the same way as all our fathers have done in their time; but we

pray thee still to continue to guide, to enlighten, and to cheer our passage through this life, in the same way as Thou didst the Israelites in their journeyings from Egypt to the desert—in cloud by day, in fire by night.

Then referring them to the 13th chapter of Exodus—

"And the Lord went before them by day in a pillar of a cloud, to lead them the way; and by night in a pillar of fire, to give them light; to go by day and night. He took not away the pillar of the cloud by day, nor the pillar of fire by night, from before the people."

After having had the lesson explained in this way, they are then told, perhaps, to sit down and write the meaning which it conveys to their minds of one verse, and on a Monday morning to bring the first two, or any other two verses, as an exercise written in prose.

The teacher should be in the habit of calling attention to the composition of particular words, and asking them to mention any others of a similar kind which they can call to mind; for instance—

Words with a prefix or affix, such as ungodly, unholy, inhospitable, incorrigible, irregular, occur; they should then be told to quote all the words they know with *un*, *in*, and *ir*, as prefixes meaning *not* when *in* is changed into *im*, as in the words improper, imperfect, &c., and why; or such words as leaflet, &c., with an affix; ask if they know any others—streamlet, ringlet, &c. A noun ending in *ist*, as chemist; quote any others, as botanist, druggist, mechanist, copyist, &c.; or an adjective in *al*, *ive*, &c., such as national, local, vocal, destructive—quote others; extensive, positive, &c., and the nouns made from them.

I merely mention a few cases that occur to me at the moment of writing, but these are quite sufficient to show what is meant.

After having heard the lesson, the monitor or teacher should tell them to sit down and write on their slates a certain number (or as many as they know) of words, nouns, adjectives, &c., having any particular prefix or affix, which may have occurred in their lesson; for instance—

Write down six adjectives ending in *al* and *ive*, six nouns ending in *ist*, in *let*.

When a word occurs which has a common root with many

others, the teacher ought to ask what others we have from the same root; instance, the word *extent* occurs as a noun; what is the word we use as a verb? extend; extending, present participle; past participle, extended: as an adjective? extensive; adverb? extensively; also extension and extensiveness as nouns.

It is also useful to show them how the same word may be used as an adjective, a noun, or a verb: for instance, such a line as the following occurs:

"How calm is the summer sea's wave."

They see the word calm here used as an adjective; let them form a sentence, using it as a noun, a verb, &c.; there was a great calm—he calmed the sea—a calm day; and they should occasionally be asked to quote passages from their books, where the word is used in all these different ways; to call to mind passages either in prose or in poetry containing particular usages of words. This teaches them their own language, and makes them recollect particular passages, both of poetry and prose, which they may have read. Lines descriptive of any particular country—of its physical character—character of its people—love of country, &c.; such as Scott's—

"O, Caledonia! stern and wild,
Meet nurse for a poetic child;
Land of brown heath and shaggy wood—
Land of the mountain and the flood."

Or—

"Dear to my spirit, Scotland, thou hast been
Since infant years, in all thy glens of green;
* * * *
Land of wild beauty and of romantic shapes,
Of sheltered valleys and of stormy capes."
T. GRAY.

Or the following from Cowper's 'Task:'

"England, with all thy faults I love thee still—
My country! and, while yet a nook is left,
Where English minds and manners may be found,
Shall be constrain'd to love thee. Though thy clime
Be fickle, and thy year most part deform'd
With dripping rains, or wither'd by a frost,
I would not yet exchange thy sullen skies
And fields without a flower for warmer France
With all her vines: nor for Ausonia's groves
Of golden fruitage and her myrtle bowers."

As most of the upper children here can repeat the poetry of their Reading Books by heart, should a passage of this kind happen to be called up, they would be asked to bring it next morning written down from memory, as an evening task.

In the later printed copies of the Dublin Reading Books, I am sorry to observe they have omitted much of the poetry; as I know of nothing which has tended so much to humanize the children in this school, and improve their minds, by calling forth the gentler feelings of their nature, as the poetry of these books.

With many of the pieces by Cowper, Scott, Mrs. Hemans, and others, such as—On Cruelty to Animals—Human Frailty—The Stately Homes of England—Birds of Passage—The Graves of a Household, the more advanced children are so thoroughly acquainted, as to be able to admire their beauties and to feel the force of them; this also has given a character to their reading which nothing else could have done, and shed a softening influence over their minds which will last through life.

The following may be taken as a specimen how children may be amused into instruction if the teacher is well up to his work. (Page 204, *Lesson Book*, No. 3.)

"O'er the heath the heifer strays
  Free (the furrow'd task is done);
Now the village windows blaze,
  Burnish'd by the setting sun.

"Now he hides behind a hill,
  Sinking from a golden sky;
Can the pencil's mimic skill
  Copy the refulgent dye?

"Trudging as the ploughmen go
  (To the smoking hamlet bound);
Giant-like their shadows grow,
  Lengthen'd o'er the level ground."

In what direction do you go home from school? West. Did you ever observe your shadow in going home? Yes, sir. Behind you or before you? Behind me, to the east of me. Does it lengthen or shorten as the sun gets lower? Lengthen. You who go home to the east, in what direction do you observe your shadows? before you or behind you? Before us. Did you ever observe them as you came to school in the morn-

ing? In what direction are you walking when you come?—Answer from one—As I go west in going home, I must be coming east when I come from home to school. Is your shadow then before or behind you? Behind me, cast towards the west. Does it lengthen or shorten as you are going to school? Shorten, because the sun is getting higher. Does it lengthen or shorten as you are going home? Lengthen, because the sun is getting lower. In what direction is the sun at noon? South. Point south. And your shadow cast to the north. If the sun were directly over your head where would your shadow be?* Under my feet, a point. In what countries is that the case? Twice a year to an inhabitant between the tropics. Now can you explain "Giant-like their shadows grow, &c." Yes, sir; as the ploughmen are going home, every step they take the sun is getting lower, and the lower the sun, the longer the shadow. Trudging means what? If it were ploughman, how must the lines be altered?

"Trudging as the plough*man goes*,
Giant-like *his* shadow *grows*."

Now look at the last two lines of the first verse. In what direction is that window at the end of the room? West.† Does the sun shine upon it when it sets? Did you ever observe it on going home in a bright sunset, how it was lighted up, and did not that explain to you what burnished meant? Yes, sir; it looks as if on fire.

The second verse—"Now he hides behind the hill," would give the teacher an opportunity of calling their attention to the beauties of the setting sun on a fine summer's evening—whether behind the hill—apparently sinking into the sea—setting on a level plain—varying according to the nature of the country. From this what a very beautiful moral lesson also might be given!

Passages of this kind occurring, which may be so strikingly

* The teacher should call attention to the adverbs of time and place, in such expressions as when and where, then and there, &c.; and point out generally how adverbs qualify verbs and other parts of speech, making them form short sentences to make clear what he says:—as

He writes well; an adverb qualifying a verb.
He writes very well; the verb *very* qualifying another adverb.
That was extremely wrong; an adverb qualifying an adjective.

† The window is in the west end of the schoolroom.

illustrated by things around them, a good teacher never would let slip; they give him an opportunity of making strong and lasting impressions on the mind, and add an interest to his teaching which almost commands success.

The following hints of a suggestive kind may be useful when a lesson happens to be on the material of clothing, of food, &c.

The word cotton, for instance, occurs: the teacher will ask, showing them a piece in the raw state, Is cotton an animal or vegetable product? Vegetable. What part of the vegetable is it? The lining of the seed-pod. Do you recollect any lines of poetry in your books which tell you about the cotton being the lining of the pod? what are they?

"Fair befall the cotton tree,
Bravely may it grow;
Bearing in its seeded pod
Cotton white as snow."

A good teacher will often call upon them to quote the poetry they have learned by heart, in illustration of a lesson they may be reading.

What is meant by raw state, raw material? The material unworked up, just as it comes from the plant. From what country do we chiefly get it? America. Is it then called an export or import from that country? *Ex* means from, and *im* in; it is, therefore, an export from America, and an import into England. Into what port does it chiefly come? Liverpool. Would you call Liverpool a manufacturing town? No, sir; a commercial seaport, into which the cotton is only brought, and then sent off to the manufacturing towns. Which are our principal manufacturing towns for cotton? point them out on the map. Do you think William the Conqueror used to wear shirts made of cotton from America?—leading them to recollect that America was not known at that time: then to show them a piece of calico, to point out the different processes it undergoes, from the raw state up to the state they see it in, how the cross threads (the woof) pass alternately over and under the others running the long way, and called the warp—calico, plain and printed, bleached and unbleached—the various articles it is made up into—how water and steam assist in moving the machinery used in manufacturing it—how in the transport of the material—consequent cheapness—the numbers to which it gives employment, &c.

Flax—showing them the plant, of course they see it is vegetable, but in this case it is the stalk, the fibre which runs the long way, that we use—laying a few fibres together lengthwise and twisting them into a thread, showing the increased strength—grown at home, and in Ireland the best—when ready, pulled up by the roots—steeped—the quantity grown at home not sufficient for our consumption. From what countries do we get it? the soil and climate of New Zealand favorable to it—its uses when manufactured, for shirting, tablecloths, smock-frocks, &c.

Hemp—take a piece of rope, untwist the threads, which will show the material; what countries do we get it from?—Its uses, cordage for ships, cart-ropes, &c.

Silk, animal or vegetable—on what particular leaf the worm feeds, and the countries we get it from, and the kind of manufactures.

Wool, leather—their shoes,* &c.; animal products—to explain how leather is tanned, the processes which the raw hide undergoes before it comes into the shoemaker's hands and the various uses to which both wool and leather are applied; when the woollen manufacture was first introduced into this country, and where it is now chiefly carried on.

Tea, sugar, coffee—the countries they come from, what particular parts of the plant, and how prepared for the market; from what other plant sugar has been extracted, so as to be made an article of commerce;—maple-sugar from Canada—from beet-root in France and Germany. That, at the present moment, thousands of people are employed in China, India, America, and every part of the world, in preparing things for our consumption in England, and to point out to them such as come into their cottages—what we send out in return, and how the commerce is carried on.

In the same way the things they are in the habit of using which are home-made, cutlery, knives, scissors, &c.; pottery, soap, &c. That, in cutlery, we excel all other nations, and that wherever they go they will find English knives, axes—point out the difference between iron and steel, showing them the steel of the knife-blade welded on the iron to make the

* To show them the difference between a natural and a manufactured product, for instance, that shoes do not grow in gardens, like cabbages, but that the materials of which they are made are sewn together by hand, &c.

cutting edge, and asking them the names of other instruments of this kind which they know—the advantages of a people who know the use of iron, and are able to turn it into steel—how they would manage to cut down a tree, or cut their meat without iron and steel—that if it had not been for these they would have been little better than savages, picking the meat off the bones with their nails; or, in a district like this, where flints abound, using little pieces with sharp edges to scrape it off;—how they would have managed to cut down a tree—the savage making his canoe,* &c.

Then again, soap—made of animal fat, vegetable oils—its importance to our personal comfort and cleanliness—in washing our linen, clothes, houses,—its civilizing effect. The teacher taking occasion to remind the children always to be neat and clean in their persons and dress, and how much this adds to their respectability—that no one looks upon a child of dirty habits with the same respect as on one that is clean (showing them something like neglect when they are dirty has a good effect). To enforce cleanliness of person and dress in the children of a school is a thing of some difficulty, and requires attention. Opportunities of reminding them of the importance of truthfulness—of cleanliness—ought never to be lost.

It must be recollected, that although children of the better educated classes may be in the habit of hearing all this from

* The writer of an account of the New Zealanders in the 'Library of Entertaining Knowledge,' observes: "The especial distinction of the savage, and that which, more than any other thing, keeps him savage, is his ignorance of letters. This places the community almost in the same situation with a herd of the lower animals in so far as the accumulation of knowledge, or, in other words, any kind of movement forward is concerned; for it is only by means of the art of writing, that the knowledge acquired by the experience of one generation can be properly stored up, so that none of it shall be lost, for the use of all that are to follow. Among savages, for want of this admirable method of preservation, there is reason to believe the fund of knowledge possessed by the community, instead of growing, generally diminishes with time. If we except the absolutely necessary arts of life, which are in daily use, and cannot be forgotten, the existing generation seldom seems to possess anything derived from the past. Hence the oldest man of the tribe is always looked up to as the wisest, simply because he has lived the longest; it being felt that an individual has scarcely a chance of knowing anything more than his own experience has taught him. Accordingly the New Zealanders, for example, seem to have been in quite as advanced a state when Tasman discovered the country in 1642, as they were when Cook visited it, 127 years after."

their parents in conversation, yet those who attend our elementary schools have no such advantage.

The following extract from the Introduction to Arnott's 'Physics,' published in 1828, ought to have a place in one of our Lesson Books. I give it here, as I think it may suggest many useful hints to the village schoolmaster:

"In our cities now, and even in an ordinary dwelling-house, a man is surrounded by prodigies of mechanic art; and with his proud reason, is he to use these as careless of how they are produced, as a horse is careless of how the corn falls into his manger? A general diffusion of knowledge is changing the condition of man, and elevating the human character in all ranks of society. Our remote forefathers were generally divided into small states or societies, having few relations of amity with surrounding tribes, and their thoughts and interests were confined very much within their own little territories and rude habits. In succeeding ages their descendants found themselves belonging to larger communities, as when the English Heptarchy was united, but still remote kingdoms and quarters of the world were of no interest to them, and were often totally unknown. Now, however, every one sees himself a member of one vast civilized society, which covers the face of the earth; and no part of the earth is indifferent to him. In England, a man of small fortune may cast his looks around him, and say with truth and exultation, 'I am lodged in a house that affords me conveniencies and comforts which even a king could not command some centuries ago. Ships are crossing the seas in every direction to bring what is useful to me from all parts of the world. In China men are gathering the tea-leaf for me—in America they are planting cotton for me—in the West India islands, they are preparing my sugar and my coffee—in Italy, they are feeding silkworms for me—in Saxony, they are shearing the sheep to make me clothing—at home, powerful steam-engines are spinning and weaving for me, and making cutlery for me, and pumping the mines, that minerals useful to me may be procured. I have post-coaches [now steam-carriages] running day and night on all the roads, to carry my correspondence. I have roads, and canals, and bridges, to bear my coals for my winter fire; nay, I have protecting fleets and armies around my happy country, to secure my enjoyments and repose. Then I have editors and printers,

who daily send me an account of what is going on throughout the world among all those people who serve me. And in a corner of my house I have *Books!*—the miracle of all my possessions, more wonderful than the wishing-cap of the Arabian Tales, for they transport me instantly, not only to all places, but to all times. By my books I can conjure up before me, to vivid existence, all the great and good men of antiquity, and for my individual satisfaction I can make them act over again the most renowned of their exploits. The orators declaim for me—the historians recite—the poets sing; and from the equator to the pole, or from the beginning of time until now, by my books, I can be where I please.' "

As the exercises which the children have to write on their slates at school, and on paper in an evening at home, are, in my opinion, very instrumental in its success, I have added a few questions, in the hope that they may be useful as hints to the teachers of village schools, who have not yet attempted anything of the kind; although the getting anything like tolerable answers may be attended with great trouble at first, and success appear to be a hopeless task, yet, in the end, it will amply repay the teacher for any pains he has to bestow upon it. In this school, in hearing a lesson read, the teachers are in the habit of leading the children to give the substance of it in their own words, as they would relate it to their mothers at home, and in this way they are led to simple descriptions of animals, and to explain in words what is passing in their own heads. In a short time some of them get very expert, and will ask for pet animals of their own to write about, such as they think they can describe best.

The questions are of the following kind:—

Write down the names of all the implements used in farming—in gardening, &c.

The names of all the birds you know, which of them come in spring, and go away at the end of summer.

Tell all you know about the swallow, how she builds her nest, feeds on the wing, &c.; about the cuckoo, &c.

Describe a sheep, and how it helps to clothe or feed you.

A cow the same, and its habits.

A horse, and the uses to which we turn it in the parish.

A dog—domestic fowl.

Write down the names of all the trees and shrubs you know, and mention which are evergreens.

What is the work which the farm labourer does in the different seasons of the year?

Describe one of the four seasons, &c.

Describe a waggon and its uses—a plough—harrow—an axe—a saw, &c.

Give a description of any of the vegetable products of the parish, and their uses.

What are the uses of soap, and in what way does it increase our comforts, civilize us, &c.? What is it made of?

Give the best account you can of all the purposes to which iron is applied in your cottages, in agriculture—in glass, lead, tin, &c.

In what ways is the power of making iron into steel useful to us?—point out all its uses in your cottages—in any other practical things you can.

Glass, what are its peculiar properties, and in what way useful to man?

What are the advantages which a people, knowing the uses of iron and steel, have over one who do not—point out any of them which occur to you.

Mention the materials of your own clothing, from what countries the raw materials come, and whether animal or vegetable.

What are the plants in the parish that furnish food to man?—food for animals.

How were books made before printing was invented, and what is the material of which paper is made?

John of Gaunt used to live where this school stands. Do you think he had tea and coffee with sugar for breakfast?—give your reasons for thinking he had or had not.

Where do we get coals from?—describe how they are brought from the coalpit to us.

Explain what are the processes of ploughing, harrowing, and what the ground undergoes in preparing for a crop of wheat—of turnips—of barley, &c.

The different ways in which milk of the cow is presented to us for food.

The oak and the elm, their properties as timber, and how each is more particularly used; bring a small twig of each

to-morrow in full leaf, and let us point out how they differ in leaf, bark, hardness of wood, &c.

Describe wheat from its being sown until it is bread—how the grain sprouts, making one shoot downwards, which is the root, another upwards, which is white until it reaches the surface of the ground, and is then the green blade—then the straw—then the ear—when ripe, the harvest—then stacking in the farm-yard—then thrashing. What is said in Scripture of the mode of thrashing corn?—pointing out how done, how in many southern climates—then winnowing, and going to the mill where it is ground (what in Scripture about grinding), and is then called flour—and so bread.

GEOGRAPHY.*

Having made them acquainted with the different bearings of particular objects of a local kind—of the towns and villages in the neighbourhood—how the parish is bounded, &c., and having well fixed on their minds the cardinal points—children very soon form tolerably correct ideas as to the nature of a map; and it is always better at first, if convenient, to have a map on the north wall of a school, as the four sides then correspond with the cardinal points where the observer is standing. This helps towards forming correct ideas; and as they generally become familiar with the map of England before any other, it is well to draw their attention at first to those counties on the extreme east or west—extreme north or south—showing them how they lie between particular meridians, or between particular parallels of latitude—to show them between what extremes of latitude and longitude the whole county is, of which the map is a representation; in this way they get a knowledge of the use of these fixed lines: until they do which a map is not properly understood; and it becomes therefore of consequence to show them their use, and the particular points from which we reckon—to show them that, having the latitude north or south, and the longitude east or west, the intersection of the two lines necessarily fixes the place wanted. They should then, for instance, pay attention to all the countries on the

* See Appendix.

coasts, noting the river-mouths, &c.; and thus by degrees fill up the whole, so as to have a correct representation of it in their minds, and know at once the bearing and position of every county on the map.

Every school should be provided with a compass, the teacher pointing out that the needle does not rest due north and south; but drawing a line parallel to it when at rest, and knowing the number of degrees which the north point of the needle is from the true north, he will very easily manage to teach them to draw a line nearly due north and south. By placing it on the floor, and having explained its directive power—that in this latitude the north point is now about 22° 30′ to the west of north—then describing a circle and drawing a diameter parallel to the needle, it will be easy to set off an arc of about 22° towards the east of the north end and towards the west of the end nearest the south, and a diameter drawn through these points will be the true meridian. The teacher of course will by degrees call their attention to the difference of counties in physical character—in mineral wealth—whether agricultural or manufacturing—why the seats of our manufacturing industry should be in those counties where coal and iron are found—how the agriculture or commerce of a county is likely to be affected by geological character—how this bears upon the character of its inhabitants.

A globe, however small, is extremely useful, and from which, among other things, not to be learned from maps, children may be made to understand how the sun comes upon the meridian of different places at different times, or perhaps speaking more correctly, how the meridians of different places come in succession under the sun—that the time of a place to the east of them is before, and to the west after the time of the place where they are—that all the meridians pass in succession under the sun in twenty-four hours; and this being understood, it may at once be explained to them how a degree in longitude corresponds to four minutes in time, &c.; the arithmetic of it they must of course be made to work out.

In the school here there are several little mechanical contrivances for giving them a correct idea of the two motions of the earth, on its axis and in its orbit, and its different positions at the different seasons of the year; also to illustrate what is meant by the hemisphere on which the rays of light

fall, and that only one half of a sphere can be illuminated at the same time—this is shown by pieces of thread, supposed to represent rays of light, fastened to a globe of wood (the sun), and then being stretched over a smaller globe (the earth), it is made visible to the eye what part of the earth will be in the light, and what in the dark; and that if made to fall upon a plane surface, the sun would shine throughout its whole extent at the same time.

It is not sufficient merely to tell the children to look at a map and point out any particular place upon it; this does not make geography an exercise of the mind, which everything they learn ought to be. They ought to be made to understand that a map is constructed on a particular plan and scale; that if one country is larger than another it will occupy a larger space in proportion upon the map—to give them ocular proof of this by showing them the different sizes of the counties on a map of England—that if two places one hundred miles apart are one inch from each other on the map, two places four hundred miles apart would be four inches, and so on—to show them how to find the distance between places, if on the same meridian, by taking the sum or difference of latitude, and turning the degrees into miles; if on the same parallel of latitude, by finding the difference of longitude, and multiplying the length of a degree of longitude in that latitude by it—or by applying a thread to the map, and measuring the distance between the two places—to apply this to the degrees of latitude, and point out why we cannot apply it to degrees of longitude.

If a school is provided with a variety of maps, then attention should be drawn to the different scales on which they are made, and why a map, perhaps of Europe or of England, is much larger than one of the world; asking them such questions as, why is not the equator found on the map of Europe? Why does not a map of England extend from the equator to the pole? Simple questions of this kind puzzle them very much, while at the same time they instruct them, and I have known children, after having been learning geography for some time, look at a map of Syria, for instance, or the Holy Land, for some minutes for the equator or the pole, and wonder why they could not find it. In looking at a map on the wall of the school, of any country not reaching to the

equator or poles, they are generally made to apply a carpenter's rule to the side of the map, and make out the scale upon which it is made; and then mark, below or above, as the case may be, on the wall were the equator would be, and in like manner to show the pole to which all the meridians ought to converge.

The being able to make out the difference of time from the difference of longitude, gives rise to a set of questions instructive in arithmetic, as well as in geography. The schoolmaster looking at the clock, observes, perhaps it is eleven; what is it in London (Greenwich)—what at Yarmouth in Norfolk? What is the difference in time between Yarmouth and the Land's End—what the difference in time between the extreme east and west of any country they may be looking at the map of. They will then be directed to look at the map, and work out the results themselves.

Short lessons of a conversational kind should occasionally be given to them, pointing out the mountain chains—their relative heights in the different parts of the world, and the directions in which they run—the course and length of the principal rivers,* comparing them with our own—their directions, and the seas into which they empty themselves—the commercial advantages which one country has over another, either from its position, its rivers being navigable far inland, projecting arms from the sea running far into it—showing them the advantages of England, Scotland, Ireland, Holland, &c., in this respect—tidal rivers, such as the Thames and the Scheldt; and hence such towns as London and Antwerp, pointing out the coal and iron districts in England, and how they have in consequence become the manufacturing districts—that settlers in new countries invariably fix themselves on the banks of large rivers, or in parts of the country where branches of the sea run up far inland, instancing America, &c.; the reasons why they do this.

Such lessons as these a teacher ought to be able to give, as they not only interest and exercise their minds, but are highly useful to them.

* Also such things as the quantity of water discharged by them compared, for instance, with the Thames, taking this as unity, that by the Danube is 65, the Volga 80, the Nile 250, the Amazon 1300, &c.; then the kind of reasoning which such facts suggest to the mind.

But in order that they may get an accurate knowledge of geography, it must not only be taught as a formal lesson, but as occasion may call it forth in the reading lessons. For instance, the inhabitants of America or Asia are mentioned—that will lead the teacher to ask, what country do *you* inhabit? Some will answer, Europe; yes, but what part of it? England, an island in the west. But what part of England? The south? Yes: but merely saying the *south* of England does not point out with sufficient accuracy where you live. Oh! in Hampshire. Well, but the English counties are subdivided (what is meant by subdivided? division of a division) into parishes; what parish are you in? and in this way working them down to the very spot.

Again, in their reading perhaps something occurs about France and Spain. The teacher: How are the two countries situated with respect to each other? in what part of Europe?—separated by what chain of mountains? Are the Pyrenees the highest mountains in Europe? What is their height compared with the highest mountains in England? Between what two seas do they run, and in what direction? How do you get out of the Atlantic into the Mediterranean? Passing through the Straits of Gibraltar, what country is on your right hand? what on your left? Do you pass Cadiz before you get at the strait or after? Then give them some account of the rock. Supposing a ship was sailing from Gibraltar to Constantinople, through what remarkable straits would it pass? What country is on the east and what on the west of the Dardanelles? On what sea is Constantinople?—built by whom? Are all the states of Europe Christian?—any other exception besides Turkey? What do we get from Smyrna, Constantinople, &c.? and to show how the commerce of the world is facilitated by the Mediterranean running between the continents of Europe and Africa, and up to Asia.

Or if anything about Petersburgh or Stockholm occurs, make them point out the course of a ship from London to either of these places—what it would be likely to take out and bring back? By whom was St. Petersburgh founded? How long since Peter the Great lived? What is the ancient capital of Russia?—then to tell them about Moscow being burnt in 1812—to point out the course of the Volga, Vistula, the Don, and into what seas they empty themselves. How is

Europe separated from Asia? observe the course of the rivers in the north of Asia, and their emptying themselves into the North Sea, consequently the mouths of them frozen up during great part of the year.

The following may be taken as an example of questioning the children when teaching a lesson such as that on America: (*Book of Lessons*, No. 3.)

America, or the New World, is separated into two subdivisions by the Gulf of Mexico and the Caribbean Sea. Soon after it was discovered, this vast continent was seized upon by several of the nations of Europe, and each nation appears to have obtained that portion of it which was most adapted to its previous habits. The United States, the greater part of which was peopled by English settlers, while they possess the finest inland communication in the world, are admirably placed for intercourse with the West India islands, and with Europe, &c.

In what direction from Europe is America? By whom discovered, and about what time? In the service of what nation was Columbus, and what were the names of its sovereigns?—the teacher telling them his difficulties, and interesting them with the story.—Who was king of England at the time? (explain the word contemporary.) Was the passage round the Cape of Good Hope to India known then? No, sir; discovered a few years later. In the service of what nation was Vasco de Gama?—and then point out to them how this discovery affected the line of commerce with the East—its course through the Mediterranean previously—the attempts made at discovery by England about the same time—Newfoundland—Nicholas Cabot—the variation in the polarity of the needle.*

The lesson says "Soon after it was discovered, each nation

* The teacher, placing the compass before them, should show what is meant by the directive power of the needle—what by its variation, dip, &c. "The variation was unknown until the time of Columbus, who observed on his first voyage that the needle declined from the meridian as he advanced across the Atlantic. The dip of the magnetic needle was first observed by Norman in 1576. The line of no variation passed through London in 1658, since that it has moved slowly to the westward, and is now near New York in America. The needle is also subject to a diurnal variation, which in our latitude moves slowly westward in the forenoon, and returns to its mean position about ten in the evening; it then deviates to the eastward, and again returns to its mean position about ten in the morning."

appears to have obtained that portion of it which was most adapted to its previous habits." What does this mean?—look at the map.—What is there that would lead you to fix upon the parts taken possession of by the English?—anything in the names of places—the names of rivers—of divisions of the country—pointing out Jamestown, New England, and New Hampshire. Where would the early settlers be likely to fix themselves? Why upon rivers? Why particularly navigable rivers? What would guide you in your choice if you were going to an unsettled country?—the teacher to point out such things as attract an agricultural people. What is the most remarkable mountain chain in the two Americas—its direction, and how it runs into the Rocky Mountains—the rivers on one side flowing into the Pacific, and on the other into the Atlantic—those into the Pacific a short course, and probably rapid, and not navigable—those into the Atlantic, as the Amazon, of great length, lazy, sleepy, running through a flat country, and therefore likely to divide into many branches—slow, navigable—the character and employments of a people how affected by this? Do you recollect any passage in your book about a river being *lazy?* Yes, sir:

> "Remote, unfriended, melancholy, slow,
> Or by the lazy Scheldt or wandering Po."

Reading at other times on this subject, the teacher would draw their attention to the Gulf of Mexico—the rivers that run into it—the course of the equatorial current, splitting into two on the coast of the Brazils; one branch going to the south, the other into the Gulf of Mexico, and called the gulf stream—most rapid between the coast of Florida and the Bahamas, striking against the coast of Newfoundland, and meeting the polar current, is again sent back across the Atlantic to the Azores, and so into itself again;—in the time of Columbus, remains of trees, also two dead bodies, were found at the Azores, washed over by this stream—how and why this encouraged him in his views.

The connection of North America with this country, when declared independent, &c., and, in like manner, how the other divisions of this large continent were, at an earlier period, connected with other European nations—Canada with France—the Brazils, &c., with Portugal—Mexico, &c., with Spain.

It is not meant that all this is to be taught to children at

one lesson, but in the course of their reading the lessons on the subject of America, introduced into their school-books; this is the sort of information given by the teachers in the school here.

After a first lesson they would be made to sit down and write on their slates the meaning conveyed to their minds by such a sentence as the one quoted above, which occurs at the beginning of their lessons: "Soon after it was discovered each nation," &c.;—at another, to sit down before the map and make an outline of the coast bordering on the Gulf of Mexico, noting the river mouths, towns, &c., or to put down on their slates the longitude of the extreme east and west points of South America, and then to work out the difference in time.

The first class of boys are reading Sullivan's 'Geography Generalized,' one of the most useful books on this subject for the purposes of teaching I have ever seen.

By most of them questions of the following kind would be answered with a good deal of intelligence: what is the difference between a great and a small circle on the same sphere? What sort of circle is the parallel of latitude on which we live? What parallels of latitude are great circles? Is the sun ever vertical to the inhabitants of Europe? In what direction is he seen, when on the meridian, by an observer north of the northern tropic? Always south. To an observer between the tropics? Explain why he would appear north or south of him at noon, according to the time of the year? To an observer in a higher southern latitude than $23\frac{1}{2}°$, where would he appear at noon? Always north.

Two men walking out of the school, the one direct east, the other west, and always keeping equally distant from the equator and pole, on what line would they walk supposing the earth a sphere? Is it a straight line? How would their reckoning of time vary? Supposing each to walk a degree a day, how would their respective noons differ from the noon of the place where they started from and from each other?—at the end of one, two, three, &c., days—at the end of 360 days? When would they meet a first, second, third, &c., time? When they come to the place from which they set out, how many times will the one walking east have seen the sun rise? How many the one walking west? What is the circumference of

the circle on which they walk, supposing them to start from a place in latitude 51°?

Two men starting from the same point on the same meridian, latitude 51°; point out their course, supposing one to go due north, the other due south, and always to walk on the same meridian. Will they have described a greater space when they meet than the two walking on the same parallel of latitude? How much longer? How will their reckoning of time differ? How long will it continue to be noon to both at the same time?

The sun is said never to set on the Queen's dominions—how is this? would he set on a belt of land running from pole to pole?—on a belt one degree wide on each side of the equator, and running round the earth?—$\frac{5}{6}$ths of the equator is in seas—$\frac{1}{6}$th in land—show this on the map, reckoning the exact number of degrees through which sea and land run.

Point out the advantage of knowing the figure of the earth, in answering the above.

Supposing a ship to sail from the Red Sea along the east coast of Africa, round the Cape of Good Hope, and so to Europe, would they always see the sun south of them at noon? Answer: No, sir. Point out, then, where they would begin to see him north according to the time of year—how this direction would vary in different latitudes up to the Cape of Good Hope. That to a people ignorant of the figure of the earth, and of its motions, and never having been beyond the Tropic of Capricorn, seeing the sun to the north of them at noon would appear as something supernatural.

Now, we find in a book written before the time of our Saviour, that in the time of Pharaoh Necho, king of Egypt, some Egyptians had made their way in a boat, setting out from the Red Sea, along the east coast of Africa, turned round what is now called the Cape of Good Hope, in passing which they would have, with their faces to the west, the sun on their right hand and towards the north of them, their left hand to the south, and of course their backs to the east. They then coasted along the west coast of Africa, found their way into the Straits of Gibraltar, which perhaps were known to them, and so sailed up the Mediterranean until they came to Egypt again, having thus coasted along the entire sea-coast of the continent of Africa. They took three years to do this in, and when they came back told people that they had seen wool

growing on trees, *and the sun at noon, when their faces were to the west, on their right hand.* At that time these were reasons for not believing the account; but with us who know more of the figure of the earth than people did then, and something about cotton, they confirm the truth of the story.

On the subject of *Physical Geography*,* which is one of great interest, many things suggest themselves—such as the varying altitude of the snow-line in different latitudes—why it should be higher near the tropics than at the equator—and why the line of the same temperature should recede further from the equator in the old continent than in the new—the limits of the different vegetable productions, and why on high mountains, even within the tropics, those of all climates, from the equator to the pole, may be found, &c., showing the effect which elevation above the level of the sea has upon climate—illustrating the explanation by instances of the vegetation of mountainous districts in low latitudes, and of low levels in high latitudes, and how it is that the temperature of the air decreases as the height above the earth's surface increases—state facts in proof of this. If the lands in the equatorial seas were increased, an increased temperature of climate would arise—if those of the polar regions, the temperature of the climate would be diminished.

NATURAL HISTORY.

The subject of Natural History, both of plants and animals, so far as they differ from each other in external form, in habits, &c., may be turned to very good account, and made the means of a great deal of useful instruction in our elementary schools.

"All this, it has been observed, children are capable of understanding—it consists in attending to the objects with which Nature presents us, in considering them with care, and admiring their different beauties, but without searching out their causes, which belongs to a higher department of knowledge: for children have eyes and do not want curiosity: they ask questions and love to be informed, and here we need only awaken and keep up in them the desire for learning and knowing what is natural to all mankind."

The children here are in the habit, as the spring and summer

* See Appendix (B).

advance, of bringing to the school plants and flowers when they first come out—small twigs of the different trees of the parish, as the foliage begins to expand—aquatic and other plants; all these, so far as a knowledge of them can be had from the organs of vision, with a little of the mind and of common sense to help it, are made vehicles of instruction.

For instance, the names of the different parts of a flower, from its root upwards, and the functions which each part performs—the nature of the root, whether bulbous, fibrous, or tap-rooted—the uniformity in number of the petals, stamen, pistil, &c.,—running through the same class of plants;—difference in the shape of leaves—some are notched and some are plain—some rough, others smooth, some oval, some round, some bright green, others dark—the under side of the leaf differing in colour from the upper, &c.: the different kinds of soils on which they find the wild plants—showing that the soil on which any particular plant is generally found is, most likely, one best suited to its habits—that some plants, and pointing out which (this they ought to know from their own observation), are only found in shady places, while others will not grow at all in the shade; that, when a flower or a leaf withers, this is from the juices making their escape into the atmosphere, and the plant being separated from its roots, cannot get a fresh supply; how aquatic plants differing in structure from those on dry land, in their air-cells, are calculated to make them float.

Then again, the small twigs of the different trees or shrubs they may bring, the oak, and the elm, and the beech—place a little twig of each side by side—how many differences in external appearance—in the leaf, the bark, the texture of the wood—the bark of the oak used for tanning, and the difference in time in the leaf coming out, and in its fall—the value of each as timber.

The acacia and the laurel—beauty of the leaves, how uniformly the leaflets of the acacia are set on, one opposite another,—how regularly in some plants the leaves are placed directly opposite to one another, others, again, alternating on opposite sides of the stem; point out the framework of the leaves, how the skeletons of them differ—to observe this in decayed leaves.

Another morning they bring different twigs of the pine tribe—the larch, the Scotch fir, spruce, or silver fir—pointing

out their thread-like leaves—that the larch is deciduous, the others not, &c. In this way they become acquainted with all the trees in the parish. That when a tree is cut down, the number of concentric rings on the face of a section of the stem marks the number of years' growth; that when they observe one ring smaller than another, it would denote a small growth for that year, and might have been caused by some peculiarity in the season, &c., such as a hard winter.

The great age of some trees, particularly yew.

These kind of observations should be made with the plants before their eyes, otherwise they have but little effect: the teacher would then tell them to sit down and describe a leaf, a twig, &c., of any of them; or some take one, some another, which is better, as this does away with the temptation to get hints from each other.

Again, calling their attention to some of the more striking differences in animals in their outward appearance and habits—the migrating of birds, and when they return, getting them to observe it; difference in the teeth and in the articulation of the jaw in animals of prey and of those which ruminate, the jaw of the latter being capable of a rotatory motion, which enables them to grind, the other not, and having long tearing teeth; the air-cells in the bones of birds so beautifully adapted to the purposes of flight—the feathering of water-birds—the down on their breasts—the peculiarity of their feet, and how differing from the feet of those that roost, &c.

But more particularly will a teacher interest his school in this department by making observations of this kind and comparisons, &c., among the birds they are in the habit of seeing, such as the cuckoo, swallow, tom-tit, skylark, woodpecker, jay, or ducks and geese.

In this way they become observers of the external world with which they are in contact; it adds both to their happiness and to their usefulness, inasmuch as all these things have a practical bearing on social life.

"These are thy glorious works, Parent of good—
Almighty! Thine this universal frame,
Thus wondrous fair: Thyself how wondrous then,
Unspeakable! who sit'st above the heavens—
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine."—Milton.

In teaching ENGLISH HISTORY, the Outlines by the Society for Promoting Christian Knowledge have been used here, being the only book on the subject which, on account of price, is attainable by the generality of children in a school like this; when reading, instruction of the following kind, in a conversational way, is given to them—on the different people who have invaded us at different periods of our history—Roman, Saxon, Dane, Norman—the Roman and other remains in this neighbourhood—the Roman road between Winton and Sarum, running through part of the parish, and anything of this kind of a local nature—how a people invading another, and remaining among them, is likely to affect their language, manners, &c.—traces of this are shown in our language; the manners and customs of particular periods—how people were housed, and clothed, and fed—the little intercourse there could be between people living even in different counties, for want of internal communication afforded by roads, &c.—there might even be famine in one county and abundance in the adjoining one;—how such evils are remedied by roads, canals, &c.;—the different inventions in science, &c., and dwelling upon the more remarkable ones, bringing with them great social improvements—paper, printing—the Reformation, impulse given to it by this;—nations contending for the honour of the invention—how this enables one generation to start from the point where another leaves off—how rapid the progress of colonies from the mother country in consequence; the improvements attending the introduction of turnpike-roads—post-office;—application of wind, water, steam, &c., as the moving power in machinery. How the introduction of the manufacture of cotton among a people, to anything like the extent of it in this country, must alter the mode of dress—the domestic employments of families, doing away with spinning, carding, knitting, &c., as home occupations; comparing the employments of a family in agricultural life at the present day with what they were at different periods. Again, the time which it took at no very distant period to travel between London and the provinces,*

* The following is the copy of a card which used to be, and perhaps is still preserved at York, in the bar of the inn to which it refers:

"York Four Days' Coach, begins the 18th of April, 1703. All that are desirous to pass from London to York, or from York to London, or

and how done;—the great men that have risen up at intervals in science, literature, &c., and in other ways;—the number and extent of our colonies, giving them such popular explanation of the nature of the constitution, one part of the legislature being hereditary, another elective, &c., as is within the comprehension of children;*—the comforts and conveniences within the reach of every class in society compared with those of earlier periods; and thus, instead of making it a dry detail of the chronological order of reigns, which in itself would not be instructive, endeavouring to give an interest to it, by speaking of those things in past ages which bore upon their daily occupations, and showing how they may improve the future by reflecting on the past.

ARITHMETIC.

Arithmetic should be made an exercise of the mind, and not merely an application of rules got by heart; in fact, it ought to be taught on a sort of common-sense principle, beginning with very simple things, and leading the children on step by step. It is difficult to fix on their minds ideas of abstract numbers, and therefore, at first, the numerals 1, 2, 3, &c., should be connected with visible objects; such as books, boys, girls, &c., and thus they should be made to understand that a number, when applied to things or objects, means a collection of units of that thing or object, but that the same kind of unit must run throughout; that in a class of children each child is an unit, and that, when we speak of a hundred children in a school, we speak of a hundred units, each of which is a child; but that we must have units of the same kind, or we could not class them all together; that we might say a hundred children when half are boys and half are girls, because the word child means either boy or girl, and in that

any other place on that road, let them repair to the Black Swan in Holbourne, in London; and to the Black Swan in Coney-street, York, at each which places they may be received in a stage-coach, every Monday, Wednesday, and Friday—which performs the whole journey in four days—if God permit."

The same distance is now travelled by railroad in eight or nine hours.

* Dr. Johnson observes in the Rambler: "That not a washerwoman sits down to breakfast without tea from the East Indies, and sugar from the West."

sense either of them is an unit; but we could not say one hundred boys or one hundred girls when there are fifty of each sort; the unit, of boys or girls, not running through the school, but only half way: we might say a hundred head of cattle, when half were sheep and half were cows, but we could not say one hundred sheep or one hundred cows. In the same way the sportsman says a hundred head of game, meaning by that hares, rabbits, &c., but in all a hundred separate heads of animals.

It will help very much to facilitate the future steps if the teacher can get the children to form correct ideas as to the local value of each figure, and this may be done by altering the position of the same figures, so as to make them represent different numbers; as 56, that is five tens and six units; 65 would be six tens and five units; 678 is six hundreds, seven tens, and eight units,—876, &c.: that 0 has no value in itself, but being placed on the right hand of a figure makes its value ten times as great as it was, because it shifts the first figure from the units' to the tens' place, and so on; as 6 by placing 0 on the right hand becomes 60, and so on, and from this to infer that by placing a 0 on the right-hand side of any number, you multiply it by ten. This is to be a sort of induction or conclusion they are to arrive at, as a general rule drawn from testing it by particular instances.

In the same way he would point out that any other figure placed on the right hand of a number multiplies that number by ten, inasmuch as it advances each figure one place to the left, and at the same time increases the number by the number of digits it contains; two figures by 100, &c.; thus 95, placing 6 on the right hand, becomes 956, or $900+50+6$; placing 65, becomes 9565, or $9000+500+60+5$. That 5, 6, &c., are always so many units, but the unit of value rises in a tenfold proportion every place the figure is advanced to the left.

When they know a little of numeration, the teacher should write on the black board, and make them thoroughly understand, writing down numbers in the following way: 69, or $60+9$; 756, or $700+50+6$; 1050, or $1000+0$ hundreds $+50+0$, making them say seven hundreds, five tens, six units; one thousand, no hundreds, five tens, no units: this they ought to be exercised in until they know what they are about.

In exercising them as a class by the repeated addition or subtraction of the same number, it may be made more of a mental exercise by checking them every now and then, testing what has been done; for instance, adding by sevens, and they have come up to 63; stop there, and ask the boy whose turn is next, whether they are correct as far as they have gone; perhaps he says, yes. Why? because $\frac{63}{7} = 9$, or seven added nine times to itself gives 63; and the probability is they are right, and one would generally let them conclude so; but here the teacher will point out to them—there may be an error of seven, or any multiple of seven, and in that case the result would still be divisible by seven, and at the same time wrong: tell them to reckon the boys, and if nine, the proof is complete. Again, supposing them to have gone on adding by sevens until the sum is 77: ask, right or wrong; the boy will answer right, because $\frac{77}{7} = 11$; then go on a little further, and a boy says, for instance, 99: divide, there is a remainder of one; it was right at 77 when the eleventh boy answered, therefore the error must be with the last three boys.

They should always be practised in asking such questions as, How many divisors has the number 12 above unity—how many 15? thus $12 = 2 \times 3 \times 2$, or 5×3 splitting the number into its factors: that all even numbers are divisible by 2, and that no odd number is. This seems simple, but if constantly repeated has a good effect.*

3	may be written	$1 + 1 + 1$, or 3
4	,,	$2 + 2$
5	,,	$1 + 1 + 1 + 1 + 1$, or 5
6	,,	$2 + 2 + 2$, or $3 + 3$
9	,,	in separate units, or $3 + 3 + 3$;

* If the teacher is acquainted with a little Algebra, he would do well to apply it to a few of the common properties of numbers. Thus in this case:

Every even number may be represented by the form $(2n)$
Every odd number by . . . . . . $(2n + 1)$
giving to n in each of these forms its successive values, 0, 1, 2, 3.

$(2n)$ becomes 0, 2, 4, 6, &c. all the even numbers.
$(2n + 1)$,, 1, 3, 5, 7, &c. all the odd numbers. Now

that a class of nine children may be made to stand out as units, but they cannot be made to stand out in twos without a remainder—in sets of three but not of four.

Thus showing them that up to 20, a class containing an even number of children may be made into more sets without a remainder, than a class containing an odd number; it is well to illustrate this practically either by parcelling out a class, or a number of small pieces of wood, thus carrying conviction both to the eye and to the mind. There is no exercise which has a better practical effect than pointing out all the factors into which numbers up to a hundred, for instance, can be broken, such as

$$24 = 2 \times 12, \text{ or } 3 \times 8, \; 3 \times 2 \times 4, \text{ or } 3 \times 2 \times 2 \times 2.$$

This subject of the number of divisors without a remainder, would lead the teacher to speak of the subdivisions of a coinage, from which he would show that a coin value twenty shillings would be much more convenient than one of twenty-one shillings, as admitting of more divisions without a remainder, and therefore of more sub-coins without fractions.

Having made them well acquainted with the first four rules, they must then be made to understand the coinage, the measures of space, time, and volume.

To get a correct idea of the comparative length of an inch, a foot, a yard, &c., and how many times the shorter measure is contained in the longer, the common carpenter's two-foot rule is of great service—show them by actual measurement on the floor what is meant by two, three, four yards, &c., as far as the dimensions of the school will permit.

Now it is clear $\left(\frac{2n}{2}\right)$ giving the quotient (n) that all even numbers are divisible by 2 without a remainder,—

$\left(\frac{2n+1}{2}\right) = n + \frac{1}{2}$, therefore the odd ones are not.

Again, the square of $(2n) = 4n^2$.

the square of $(2n+1) = 4n^2 + 4n + 1$.

Or,
$$\frac{4n^2}{4} = n^2.$$
$$\frac{4n^2+4n+1}{4} = n^2 + n + \frac{1}{4}.$$

Therefore the square of every even number is divisible by 4 without a remainder.

The square of an odd number is not.

The motions of the hands on the face of the clock should be pointed out*—what space of time is meant by a minute, an hour, and a year—all words in use as measures of time—the same as to measures of volume.

When the children understand these things, it will be found most useful to practise them in little arithmetical calculations connected with their own domestic consumption, or applying personally to themselves, such as—

Supposing each person in a family† consume $16\frac{1}{2}$lbs. of sugar in a year, consider each of you how many your own family consists of, and make out how much sugar you would use in one year.

How much would it cost your father at $5\frac{1}{2}d.$ per pound, and how much would be saved if at $4\frac{1}{2}d.$ per pound?

This village consists of 1120 people, how much would the whole village consume at the same rate? How much the county, population 355,004?

In this way a great variety of questions connected with sugar, coffee, their clothing, such as a bill of what they buy at the village shop, groceries, &c.—a washing bill, &c., may be set; and when told to do a question or two of this kind in an evening at home, it will very often be found to have been a matter of great interest and amusement to the whole family.

In teaching them arithmetic, such simple questions as the following occasionally asked will, by degrees, lead them to form correct ideas of fractional quantities.

How many pence in a shilling? Twelve. Then what part of a shilling is a penny? One twelfth. Then make them write it $\frac{1}{12}$ on their slates.

How many twopences in a shilling—threepences, &c.?

Then what part is twopence, threepence, &c.? $\frac{1}{6}$, $\frac{1}{4}$, &c.

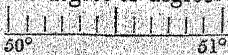
Again, how many shillings in a pound? Then what part of a pound is one, two, three . . . . nineteen shillings?

$\frac{1}{20}$, $\frac{2}{20}$, $\frac{3}{20}$, and so on to $\frac{19}{20}$, $\frac{20}{20}$ or a whole.

* Many of the labouring class in agricultural districts, even when grown up to manhood, cannot read the clock face.

† Each boy adapting the question to the number of his family, varies it without trouble to the teacher, and thus no temptation is offered to any one to rely on his neighbour. In arithmetical calculations they can easily catch a result from others; this the teacher should in every way discourage, or he will very soon find that two or three of the sharper boys in a class know something about it, the rest nothing. Tell them to rely upon themselves, and ask questions if they are at a loss.

In the same way with measures of space, thus leading them by gentle degrees to see that in numerical fractions what is called the denominator denotes the number of equal parts into which a whole is divided, and the numerator the number of parts taken.

When sufficiently advanced to commence the arithmetic of Fractions, the teacher will find it of great service in giving them correct ideas of the nature of a fraction, to call their attention as much as possible to visible things, so that the eye may help the mind — to the divisions on the face of a clock—or of the degree or degrees of latitude on the side of a map, thus 

showing that a degree, which here represents the unit, is divided into twelve equal parts—and then reckoning and writing down

$\frac{1}{12}$, $\frac{2}{12}$, $\frac{3}{12}$, $\frac{4}{12}$, $\frac{5}{12}$, $\frac{6}{12}$ (or $\frac{1}{2}$), $\frac{7}{12}$, $\frac{8}{12}$, $\frac{9}{12}$, $\frac{10}{12}$, $\frac{11}{12}$, $\frac{12}{12}$ or units, showing how these may be reduced to lower terms, and that the results still retain the same absolute value—that the value of a fraction depends upon the relative, and not upon the absolute value of the numerator and denominator; as

$\frac{2}{12}$ and $\frac{1}{6}$, $\frac{3}{12}$ and $\frac{1}{4}$, $\frac{4}{12}$ and $\frac{1}{3}$, $\frac{6}{12}$ and $\frac{1}{2}$, &c.,

have in each case the same absolute value.

In casting his eye round a well-furnished schoolroom, the teacher will see numberless ways in which he may make the nature of a fraction clear to them, as counting the number of courses of bricks in the wall — say it is fifty, as they are of uniform thickness, each will be $\frac{1}{50}$ of the whole height — placing the two-foot rule against the wall and seeing how many courses go to making one foot, two feet, &c., there will be such and such fractions—or supposing the floor laid with boards of uniform length and width, each will be such and such a fraction of the whole surface, taking care to point out that when the fractional parts are not equal among themselves they cannot put them together until they are reduced to a common denominator, and the reason of all this. In this way, and by continually calling their attention to fragments of things about them and putting them together, children get a correct idea of numerical fractions at a much earlier age than is generally imagined.

The following kind of question interests them more than very abstract fractions; the teacher should try to form questions connected with their reading.

What are the proportions of land and water on the globe? $\frac{1}{3}$ land, $\frac{2}{3}$ water. What do you mean by $\frac{2}{3}$? A whole divided into three equal parts, and two of them taken. Here the teacher would put a piece of paper into a boy's hands, and tell him to tear it into three equal parts, and show the fractions; or by dividing a figure on the black board.

What proportion of the land on the globe does America contain? $\frac{1}{3}$. What Asia? $\frac{1}{3}$. Africa? $\frac{1}{5}$. Europe? $\frac{1}{15}$. And Oceanica? $\frac{1}{15}$. Now, putting all these fractions together, what ought they to give? The whole land. The unit of which they are the fractional parts was what? The land on the globe. Work this out. Africa $\frac{1}{5}$ or $\frac{3}{15}$; Europe and Oceanica, each being $\frac{1}{15}$, these with Africa will be $\frac{5}{15}$, or $\frac{1}{3}$. America and Asia together are $\frac{2}{3}$, and adding $\frac{1}{3}$ to this gives $\frac{3}{3}$, or 1 for the whole.

Having been taught this and decimal arithmetic, they should be taught to work out most of their sums decimally, and made to reason about them as much as possible, rather than to follow a common rule—for instance:

What is the interest on £500 at 5 per cent. for two years? —5 per cent. means what?—the interest on a hundred pounds for a year: then the interest of £1 will only be the one hundredth part of that: work it out, ·05—the interest of £2 will be twice as great; of £3 three times as great; and of £6 six times as great, &c. Having the interest for one year, the interest for any number of years will be the interest for one, multiplied by that number.*

* The following algebraic formula may be useful:

Let P = the principal.
r = the interest of £1 for one year.
n = the number of years, or the time for which it is put out.

Now if r is the interest of £1 for one year, it is clear the interest of 2, 3, 4, &c. P£ will be twice as much,

or $2r$, $3r$, $4r$ . . . . Pr interest for one year.—

The interest for 2, 3, 4 . . . . n years will be

$$2\,Pr,\ 3\,Pr,\ 4\,Pr\ .\ .\ .\ .\ .\ nPr,$$

$$(1)\ \text{the interest} = nrP,$$

we have the amount, being the principal added to the interest, $M = P + nrP$. Now, in this equation there are four quantities, any three of which being given the fourth can be found. *Ex.*

Children sometimes get into the way of working out questions of this kind, without having any definite idea of what

Ex. Interest on £250, for $2\frac{1}{2}$ years, at 5 per cent.

$$\text{Here } P = 250$$
$$r = \frac{5}{100} = \cdot 05.$$
$$n = 2\tfrac{1}{2} = 2\cdot 5.$$
$$\therefore \quad I = 250 \times (\cdot 05) \times (2\cdot 5) = 31\cdot 25£,$$
$$\text{and } M = 250 \times 31\cdot 25 = 281\cdot 25£.$$

But the above formula is much more important than the ordinary rule, inasmuch as it accommodates itself to every possible kind of case.

A certain sum put out to interest at 5 per cent., in four years amounts to £250 10*s*.; what was the sum put out?

In this case, M, r, and n are given to find P.

Or the sum put out was £30, and in two years amounted to £33; what was the rate per cent.?

Here M, P, and n are given to find r.

The cases where all, rate per cent., time, &c., are fractional, are quite as easy as the rest, except in having a few more figures to work out.

The whole expenditure of a family in a year is A pound, of which a per cent. is spent in bread, b in tea, c in clothes, d in house rent, e in taxes, &c., what part of the whole income is spent in each of these articles, and give an expression for the whole?

$\frac{a}{100}$ = part of every £ spent in bread, and $\frac{Aa}{100}$ = what is spent in a year.

$\frac{b}{100}$ = the part of each £ in tea, and $\frac{Ab}{100}$ of the whole income.

In the same way $\frac{Ae}{100}$ = that in taxes in the year.

Therefore $\frac{Aa}{100} + \frac{Ab}{100} + \frac{Ac}{100} + \&c. = A.$

Or, $\frac{A}{100}(a + b + c + \&c.)$ = the whole expenditure.

And if the annual income of a family is P£ per annum, $P - \frac{A}{100}(a + b + c + \&c.)$ will be the state of the pocket at the end of the year. When this expression is negative, it means they have exceeded their income. When it is = 0, they have just spent their income; and when it is positive, they have saved money.

A mass M of three metals, of which c per cent. is copper, s per cent. silver, and g per cent. gold; how much of each?

$$\frac{Mc}{100} = \text{the copper.}$$
$$\frac{Ms}{100} = \text{the silver.}$$
$$\frac{Mg}{100} = \text{the gold.}$$

Or,

is meant by so much per cent., &c.; this they should be made thoroughly to understand, as bearing upon many other questions besides those on interest, as will be seen from the examples given; also what is meant by so much in the shilling, so much in the pound, &c.,—that if a person spends twopence in the shilling in a particular way, and lays out two,

$$\text{Or,} \quad M - \frac{M}{100}(c + s).$$

Suppose the mass 1000 lbs., of which 25 per cent. copper, $40\frac{1}{2}$ per cent. silver, and the rest $34\frac{1}{2}$ gold; how much of each?

Here $\quad M = 1000, \ c = 25, \ s = 40{\cdot}5$, &c.

$$\therefore \frac{Mc}{100} = \frac{1000 \times 25}{100} = 250 \text{ lbs. of copper.}$$

$$\frac{Ms}{100} = \frac{1000 \times 40{\cdot}5}{100} = 405 \text{ lbs. of silver.}$$

$$\frac{Mg}{100} = \frac{1000 \times 34{\cdot}5}{100} = 345 \text{ lbs. of gold.}$$

The skilful teacher who knows a little algebra may see a very extensive application of it in this way, and the satisfaction and instruction to a boy in being able to work out easy formulæ of this kind, and adapt them to particular cases, is beyond comparison greater than being taught by rules.

This makes it highly desirable that all our schoolmasters should be able to teach so much of the rudiments of algebra as to apply it to simple calculations of this kind. The merely being able to substitute numerical values for the different letters in an algebraical formulæ is of service.

For instance, that

(1.) $(a+b)\ (a-b) = a^2 - b^2$: that this means that the sum of two quantities multiplied by their difference is equal to the difference of their squares.

(2.) That $(a+b)^2 = a^2 + 2ab + b^2$, or that the square of the sum of two numbers is equal to the sum of their squares, increased by twice their product.

(3.) That $(a-b)^2 = {}^2 - 2ab + b^2 = a^2 + b^2 - 2ab$, or that the square of the difference of the numbers is equal, or the same thing as adding the squares of each separate number together, and then diminishing this by twice their product.

In each of these cases let $a = 6$, and $b = 4$; then $(a+b)\ (a-b)$ would become $(6+4) \times (6-4)$, or $10 \times 2 =$ the square of 6 or 36, diminished by the square of 4 or 16, or $(6^2 - 4^2) = 20$.

(2.) $(6+4)^2$ or $10^2 = 6^2 + 4^2 + 2 \times 6 \times 4$.
or $36 + 16 + 48 = 100$.

That is, it is the same thing if you add the two numbers together, and square the sum, or square each number separately, add them, and to this add twice their product.

(3.) $(6-4)^2 = 2^2$ or $4 = 6^2 + 4^2 - 2 \times 6 \times 4$.
or $36 + 16 - 48 = 4$.

three, ten shillings, he spends *4d.*, *6d.*, *20d.*, &c., in that particular thing.

A penny in the shilling is twenty pence in the pound, twenty pence in one pound is one hundred times that in a hundred pounds, and would be called so much per cent. The same in the common rule of three; they get into the way of stating their questions mechanically; but what the teacher should do is, instead of saying as 1 yard : *2s. 6d.* : : 50 yards to the answer; he should say, if one yard cost *2s. 6d.* two yards will cost twice as much; three yards three times; 50 yards 50 times as much, having recourse to the common-sense principle as much as possible.

The following questions, with those at the end of this section, may be useful to the teacher, as bearing upon the economic purposes of life, and will suggest others of a like kind:—

The population of the parish in 1831 was 1040, at the census of 1841 it had increased 7 per cent., what is it at present?

In the population of the parish 20 per cent. of them ought to be at school; in this parish, containing 1040, only 12 per cent. are at school; how many are at school? and how many absent who ought to be there?

The population of the county in 1841 was 355,004;—82·8 per cent. were born in the county, 14·9 in other parts of England, 0·5 in Scotland, and 0·9 in Ireland; what number were born in each country?—how many in number, and what per cent. are unaccounted for?

Give the average of the parish, how many to the square acre; number of the houses, how many to a house, &c. These questions ought also to be the vehicle of a good deal of instruction on the part of the teacher.

A sheet containing the names of the towns in each county, arranged by counties, and giving in a tabular form the population in adjoining columns, according to the census of 1831 and of 1841, is to be had for a shilling, and offers great facility to a master for making questions of this kind; as well as affording useful statistical information.

In teaching them superficial and solid measure the following mode is adopted:—

They are first shown, by means of the black board, what a square inch, foot, yard, &c., is, by proofs which meet the eye; that a square of two inches on a side contains four square

inches; of three inches on a side nine square inches, and so on; or, in other words, that a square of one inch on a side could be so placed on a square of two inches as to occupy different ground four times, and in doing this it would exactly have occupied the whole square, one of three inches, nine times; thus showing clearly what is meant by a surface containing a certain number of square feet, &c.

The same illustration with an oblong, say nine inches by two, three, &c., two or three figures of figures so divided are painted on the walls.

Solid Measure.

The teacher takes a cube of four inches on a side, divided into four slices of one inch thick, and one of the surfaces divided into sixteen superficial inches; to this slice of one inch thick, containing sixteen solid inches, add a second, that will make 32, and so to the fourth, making 64; so that they now have ocular proof so simple that they must understand that the superficial inches in a square, or rectangle, is found by multiplying together the number in each side; the contents of a regular cube by multiplying the number of linear inches on one side by the number of slices.

To apply this:

The master tells one of the boys to take the two-foot rule (a necessary thing in a village school), measure the length and breadth of the schoolroom. Yes, sir.

Length 26 feet, breadth 16 feet. What is the figure? An oblong—sides at right angles to each other. Multiply length and breadth—what is the area?

To another—Look at the boards of the floor; are they uniform in width? How are they laid? Parallel to each other. The breadth of the room you have got, and, as the boards are laid that way, you have the length of each board; measure the width of a board. Nine inches. Reckon the number of boards. What is the area of the room? Does it agree with your first measurement? If not, what is the source of error; the boards will turn out to be unequal in width.

The door—what is the shape of the opening? An oblong, with one side a good deal longer than the other. Measure the height—the width: now what number of inches of surface on the door?

The rule again. Measure the thickness. Now how many solid inches?

The door-posts. Measure the height, width; now the depth. How many solid inches of wood in one post? How many in the whole door-posts? How many solid inches in a foot? Turn it into feet.

In the same way they may apply the rule to find out the surface of a table, a sheet of paper, surface of a map, a page of a book, &c., but always making them do the actual measurement, first taking one child, then another.

Again the room—we have got the area—tell us how much water it would hold, if we could fill it as high as the walls; we have got two dimensions, what is wanting?—The height. We cannot reach up, sir.—Take your rule. Measure the thickness of a brick with the mortar.—About four inches.—Measure the first three courses.—A foot, sir.—Reckon the courses of the wall.—Thirty-six.—Then the height is what?—Twelve feet. Now find out the solid contents of the room.

Find the surface and solid contents of a brick.

In fact, the two-foot rule is to the village school what Liebig says the balance is to the chemist.

Another practical application, which works well in giving fixed ideas of linear measure, is the following:

Take a hoop, say of two feet diameter; apply a string to the circumference; measure it.—Rather over six feet.—Another of three will be found to be nine, and, by a sort of inductive process, you prove that the circumference is three times the diameter: when farther advanced, give them the exact ratio, 3·14159, which they will work from with great facility.

Boys! make a mark on the hoop: let it rest on the floor, the mark being directly opposite the point which touches the floor;* trundle it, stopping every time when the mark rests upon the floor, and let another boy make a chalk mark where it touches; now take your *two-foot rule* and measure between

* The teacher who has sufficient mathematical knowledge may exercise himself in trying to make out the nature of the curve traced out, by any given point in the surface of the hoop, between two successive contacts with the floor. A curve of very curious properties, which interested mathematicians very much about 200 years ago, and was made out by the famous Pascal when labouring under a fit of toothache: it is the curve in which the pendulum keeping true time vibrates.

each mark. What is it?—Six feet, twelve feet, eighteen feet, &c.—And the hoop has been round how many times at each mark?—Once at the first, twice at the second, three times at the third, &c.—Now, you see, if you trundle your hoop over a piece of level ground, and reckon the number of times it has gone round, you can tell the length of space it has gone over.

How many miles to Winchester?—Nine, sir.—Measure the height of your father's cart-wheel, and tell him how often it will go round in going to market. Tell him he must not zig-zag. The teacher should point out the sources of error. The philosophy of common life and everyday things is most attractive to them, and a book of this kind, if well done, would be a most useful one for our village schools.

This two-foot rule, and other appliances, setting to work both hands and head, amuses at the some time that it instructs, and gives a sort of certainty to their knowledge, fixing it in a way that learning things by mere rote never can.

In order that they may get correct ideas of what is meant by lines parallel and inclined to each other, and of a square, a circle, a triangle, &c., I have had painted on the upper part of the walls, above the maps, four series of simple figures marked, Series A, No. 1, 2, 3, angles and triangles. Series B, No. 1, squares and parallelograms. Series C, circles, &c. a square and a rectangular parellelogram, divided into linear inches. These figures are easily referred to, extremely useful, occupying no space which is wanted for other things, and cost nothing.

Of the simple solids the school is also provided with models, and these, with the figures on the wall, may be called into use in almost numberless ways.

What is the shape of the room—of the door—of a brick—of a book—table, &c.?—a square or parallelogram on Series B, No. 1, No. 2. Look at the beam running between the walls, what are the figures of the two surfaces? What of a section perpendicular to either surface?—what slantwise?

The stove in the room, what is its figure?—A hollow cylinder.—The pipe carrying away the smoke?—The same.—What would the figure of a section of the stove parallel to the floor be?—of the pipe?—A circle, No. 2, Series C.—What of a section perpendicular to the floor? &c. The different sections of a cube—or any solids which may be about the room—but

always referring to the exact figure on the wall. These figures will often supply the place of the black board.

Again, tell a boy to turn the door on its hinges as far as he can—to find out what solid it would trace out if he could turn it entirely round.—A cylinder like the stove, but much larger. —What is the section of the solid part of the stove?—A ring inclosed between two concentric circles.—Concentric, what?— If the door were a right-angled triangle, what figure would it generate by going quite round on the hinges?—A cone, like a sugarloaf.—What if a semicircle, the line between the hinges the diameter?—A globe: and so on. Then again, the outer edge of the door and a line parallel to it, at 2, 3, &c. inches apart, would trace out a solid ring. What would the door trace out if, instead of revolving round its hinges, it revolved round one of its ends; and to illustrate this still further, fasten two pieces of string of unequal lengths to the top of a stick, which place perpendicular to the floor, then let two boys taking hold one at each end, walk round the stick, they will clearly see, that the finger of the short-stringed boy describes the inner surface, and of the long-stringed the outer surface—that every point in a circle is equally distant from the centre— explain what is meant by circles being in different planes— what by concentric circles—and then the teacher will ask them, if the strings were 2, 3, 4 feet, &c. long, what the circumference would be; at first some of them would say six feet, nine feet, &c., not seeing that their piece of string was the radius and not the diameter; difference to be pointed out, and that the circumferences of circles are in proportion to their diameters.

Here they may be shown that the area of a circle is the circumference $\times \frac{\text{radius}}{2}$ or the circumference $\times \frac{\text{diameter}}{4}$, and since $3{\cdot}14159$ is the circumference of a circle whose diameter is unity, $3{\cdot}14159 \times \frac{1}{4} = {\cdot}78539$ is the area, and that the area of circles are to each other as the squares of their diameters; this expression they can work with practically afterwards, in measuring timber, &c.*

The contents of a cylinder:

The teacher should not be content with merely showing them how to find the contents of a cylinder, or any other

* See Appendix (B).

regular figure, but should point out to them, in this case, for instance, anything in the room of a cylindrical form, such as the stove if round, the pipe which carries off the smoke, &c.; and taking the diameter of a section, and from this finding the area of it, and multiplying into the height or length would give the solid contents: that for an iron roller, or any other roller hollow in the middle, they must take the diameter of the outer and inner surface, get the area of these sections, and subtracting them from each other, would give the area of a section or ring which, multiplied into the length of the roller, would give the quantity of solid matter in it; thus calling their attention, and actually measuring vessels, &c., the shape of which they are familiar with.

This, of course, applies to other regular solids than the cylinder.

In the case of the cylinder, let $d =$ the outer diameter, d' the inner, then

$(\cdot 78539)\ d^2 =$ area of outer circle,

$(\cdot 78539)\ d'^2 =$ area of inner circle;

and $(\cdot 78539)\ (d^2 - d'^2) =$ area of section of the ring;

and if h denote the height, the solid contents will be

$(\cdot 78539)\ (d^2 - d'^2)\ h$; then to give particular values to d, d' and h, and work out the results.

Examples for Practice.

A boy at the age of 15 begins to save $7\frac{1}{2}d.$ per week, what will he have saved at the end of one, two, three, &c. years.

What will his savings amount to when he reaches the age of twenty-one? And what would it be if put into the savings' bank at the end of each year, interest three per cent.

Supposing at the age of 21 he begins to save 1*s.* per week, and at the end of each year puts it into the bank, what would he have when he is 31 years of age?*

A goes to the village shop and lays out 10*s.* per week on an average, for necessaries for his family, every week in the year; but, for want of thought and of understanding his own interests, has got into the habit of running a bill, and having

* Such questions not to be drily set, but to have their bearings explained.

his things booked, as it is called; for this the shopkeeper is obliged to charge 10 per cent. more than for ready money. How much does *A* lose by this in the year?—or how much more does he pay than the ready-money customer?*

Supposing the whole expenditure of a parish in rates to be £920 10*s*. in the year, and the whole property rated at £5276 9*s*. 4*d*., what is that in the pound?

Supposing the number of acres in the parish to be 7000, what would that be per acre?

A spends £250 10*s*. 6*d*. per annum; of this 3*s*. in the pound is paid for house rent, 9*s*. 8*d*. in food, 3*s*. 4*d*. in clothing, the rest in sundries; how much in the pound is paid in sundries; and what is his absolute expenditure in each of the above things?

Supposing him to save £80 per annum out of the above income, and his proportionate expenditure in each article as above, what would be the sum spent for each?

The whole amount of taxation in this country is upwards of

* The following extract from 'An Educational Tour in Germany,' &c. affords a very useful and practical hint to the schoolmaster:

"*In Holland I saw what I have never seen elsewhere, but that which ought to be in every school—the actual weights and measures of the country.* These were used not only as a means of conveying useful knowledge, but of mental exercise and cultivation.

"There were seven different liquid measures, graduated according to the standard measures of the kingdom. The teacher took one in his hand, held it up before the class, and displayed it in all its dimensions. Sometimes he would allow it to be passed along by the members of the class, that each one might have an opportunity to handle it, and to form an idea of its capacity. Then he would take another, and either tell the class how many measures of one kind would be equivalent to one measure of the other, or, if he thought them prepared for the question, he would obtain their judgment upon the relative capacity of the respective measures. In this way he would go through with the whole series, referring from one to another, until all had been examined, and their relative capacities understood. Then followed arithmetical questions, founded upon the facts they had learned,—such as, if one measure full of anything costs so much, what would another measure full (designating the measure) cost, or seven other measures full? The same thing was then done with the weights.

"In the public schools of Holland, too, large sheets or cards were hung upon the walls of the room, containing fac-similes of the inscription and relief—face and reverse—of all the current coins of the kingdom. The representatives of gold coins were yellow, of the silver white, and of the copper, copper colour."—Mann's '*Educational Tour*,' with Preface by W. B. Hodgson, LL.D.

50 millions, supposing it is this sum, and that every twenty shillings paid in taxes is disposed of as follows:

	s.	d.
Expenses of the army and navy	7	2
King's judges, &c., and other departments of state .	0	10
Interest of the national debt	12	0

What is the exact sum paid to each?

What would be the expense of digging three acres, two roods, and 20 perches of ground at 4*d.* per pole? What of double trenching it for the purpose of planting, at 10*d.* per pole?

How many trees to plant an acre at such and such distances, &c.?

A pole or perch of land is 16½ feet square, the usual measure, but here they have a measure for underwood called wood-measure, a pole of which is 18 feet square. How much is the wood-acre larger than the ordinary acre?

A labourer agrees to move a piece of earth 25 feet long, 15 feet wide, and 10 feet high, a certain distance at 1*s.* 6*d.* per cubic yard, what would his work come to?

A pair of horses plough ¾ of an acre in one day, the width of each furrow is one foot. How many miles will the boy walk who drives the plough?

Supposing the furrows were only nine inches or six inches broad, how far would he have to walk? Work this out, and reduce the difference into yards.

A window is five feet nine inches high, four feet six inches broad. How many square feet of glass for a house of ten windows?

How many panes, each nine inches by twelve inches, and what would the cost be at   per foot.

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*GEOMETRY.

A knowledge of some of the more simple parts of geometry is quite necessary for any schoolmaster who wishes to be thought competent to his work, or to stand in what may be looked upon as the first class of teachers in our elementary schools. For this purpose it is highly desirable that they should at least know so much of the subject as would enable them to teach the first three books of Euclid, with a few propositions out of the other books. Many of the propositions in

the first three books are of easy application to the mechanic arts, particularly to the carpenter's shop, to the principles of land-measuring, &c., and an edition of these, pointing out such propositions and their application, with a few practical deductions from each, would be of great use in our elementary schools.

There are many of the appliances of the carpenter with his tools, and of other mechanic trades, so strictly geometrical and so easy of proof, as to be easily learned, and the workman who knows them, instead of being a machine, becomes an intelligent being, and has sources of enjoyment opened out to him which many of them would turn to a good purpose.

Even a knowledge of the axioms of Euclid, such as "things which are equal to the same, are equal to one another."

If equals be added to equals the wholes are equal.

If equals be added to unequals, the wholes are unequal, &c.: suggest modes of reasoning, which are extremely useful; and a thorough knowledge of the kind of reasoning in the propositions of the three books gives a man a habit and a power of drawing proper conclusions from given data, which he would scarcely be able to acquire with so little trouble in any other way.

Children may easily be made to understand what is meant by the terms perpendicular, horizontal, right angle, and lines parallel to each other, by referring to the things in the room.

Thus the walls are perpendicular, or at right angles to the floor—the boards are horizontal and parallel to each other—the courses of bricks are parallel—the door-posts perpendicular to the floor, &c.; the beams, rafters, &c., of the roof, all might be referred to as illustrating things of this kind.

The way in which the circle is divided ought to be understood; the number of degrees in a quadrant, &c.; that the three angles of a triangle are equal to two right angles; and therefore if a triangle is right-angled, or has one right angle, the remaining two must be equal to a right angle.

The proposition that if two sides of a triangle are equal, the angles opposite are equal, and the converse.

To bisect a given rectilineal angle.*

* The following is a very interesting and useful application of this proposition in showing how a meridian line may be laid down by it:

Tell the boys to stick in the ground, and in the direction of the plumb-

To draw a perpendicular from a given point in a line, or let one fall on a line from a point without it.

The one that either of two exterior angles is greater than the interior and opposite angle—showing from this how the angle under which an object is seen diminishes as you recede from, and increases as you advance towards it.

The proposition about the areas of triangles and parallelograms, as applying to the superficial measurement of rectilineal figures.

The 47th in the first book, that the square of the side opposite the right angle is equal to the sum of the squares on the other two sides. All these from the first book are particularly of practical application.

It will be found very useful for fixing on their minds any particular geometrical truth likely to be of use to them afterwards, if the teacher tests it, by application to actual measurement, and not to rest satisfied with proving it merely as an abstract truth; for instance, in this schoolroom there is a black line, marked on two adjoining walls, about a foot from the floor; as the walls are at right angles to each other, of course these lines are also; they are divided into feet and divisions of a foot, numbered from the corner or right angle, then taking any point in each of these lines, and joining them by a string, this forms a right-angled triangle. The boys have learned that the sum of the squares of the two sides containing the right angle is equal to the square on the third side, the teacher will tell them, for instance, to draw a line between the point marked six feet on the one and eight feet on the other; square each number, add them together, and extract the square root, which they find to be 10; then they

line, a straight rod, to observe and mark out the direction and length of its shadow on a sunny morning before twelve o'clock, say at eleven: to observe in the afternoon when the shadow has exactly the same length; join the two extremities of the shadows, and on the line which joins them, which is the base of an isosceles triangle, describe an equilateral triangle; a line drawn from the point where the staff goes into the ground to the vertex of this triangle will be the true meridian, or by simply drawing a line from the stick to the middle of the line joining the extremities of the shadows.

Place the compass on the line, and let them observe how much the two meridians differ: that the length of the shadow, at equal intervals from noon, will be the same both in the morning and in the afternoon, &c.

apply the foot-rule—measure the string, and find it exactly ten feet by measurement.

Again, draw the line between the point marked five feet on one and seven on the other; work it out, and they get a result 8·6 feet; the teacher would ask is ·6 half an inch or more?—More by a tenth.—They then measure the piece of string which reached between the extreme points, and find it perfectly correct.

The teacher would then point out that this would always be the case when the walls stand at right angles to each other. The bricklayer knows this, and laying out his foundation walls measures eight feet along one line, and six along the other, from the same corner; he then places a ten foot rod between the extreme points, and if it *exactly* reaches, he is satisfied his walls are square.

Through the middle of the line on the end wall a vertical line is drawn, and divided in the same way, and higher up on the wall are marked three parallel lines an inch, a foot, and a yard in length; these are very convenient to refer to as a sort of standard of measure,* and to show what multiple of an inch, a foot, a yard, &c., any lengths of the other lines are.

A teacher with a little knowledge of geometry will see numberless ways in which these lines may be made useful. I feel a difficulty in entering further into this without having recourse to diagrams, which in the printing of this book I did not contemplate.

The following occur to me as simple:—Tell a boy to measure the width of the door and its height; now what length of string will it take to reach between opposite corners? work it out: then to take a piece of string and measure,—they correspond; the same for his book, slate, a table, &c. Measure the two sides of the room—find the line which would reach from corner to corner.

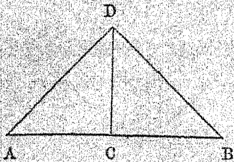
Again, let one of the boys hold the string against a fixed point in the upright wall, say four feet high, and another extend it to any point towards the middle of the floor—they see this forms a right-angled triangle; another boy takes the rule, measures from the point where the string touches the floor to

* It is recorded, that in the time of Henry the First, the length of the king's arm was the standard yard: this gives an idea of the rudeness of the age.

the base of the black line, taking this as one side, the height four feet as the other, they work it out, and then measure as before. This testing of theory by practice gives them a great interest in what they are doing.

As an example of the carpenter applying a proposition in Euclid, take this:

Not having his square at hand, he wishes to draw one chalk line at right angles to another, from a given point in it.



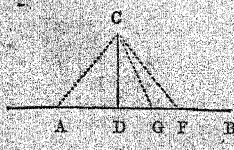
From C in the straight line AB he marks off with his compasses on each side of it, CA and CB, equal to each other, he then places his rule in the direction, CD, as nearly perpendicular as he can guess, and draws a line, CD, along it; from any point D he stretches a string to A, and if turning it on D he finds the same length exactly reach to B, CD is at right angles to AB.

If he wanted to fix a piece of wood CD in AB, and at right angles to it, he would of course measure in the same way; if AD were longer than DB, he would lean it towards A until they were equal, if shorter he would have to move it in the contrary direction.

If he take his square, and place one side on the line AC, the other will fall in a direction perpendicular to it, and he could run his chalk line along the edge.

The teacher would also point out, that when the lines are perpendicular, the angles ACD DCB are equal; that if CD lean more towards A than towards B, the angle ACD will be less than DCB, &c.

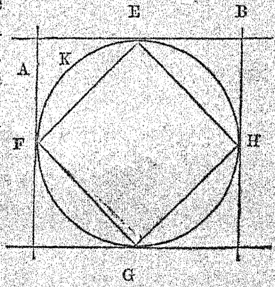
Again, another very easy application of a simple proposition in the first book, to show that if AB is a straight line, C



a point without it, the perpendicular CD is the shortest line from C to D; any other line CF, CG, &c. would be greater than CD, as being opposite to the greater angle in the same triangle, and although every successive line CF, CG, keeps lessening as it gets nearer to D, yet at D it is least, and when it passes through that point, the length of a line from C to any point in AD

goes on increasing as that point gets farther from D. It will easily be seen on what proposition in Euclid these remarks depend, and the young schoolmaster may profit by them, and apply other propositions in the same way.

Take this as a case where the eye may be made to help the mind: take a square thin piece of deal, say one foot on a side, and a circle of the same one foot in diameter; place the circle on the square so that it becomes inscribed on it, the figure will be this. They see clearly the difference between the area of the square and the inscribed circle is the sum of the four irregular corners AEKF, &c., contained between the sides of a triangle and the arc in each case.



Find this difference, divide it by four, that will give any one corner AEKF: then inscribe a square in the circle: the difference between this and the first square will be the four triangles AEF, &c., and which will be found equal to the inscribed square FEHG. Dividing by four will give one of the triangles.

Let the side of the square $= a$, which will also be the diameter of the circle:

Then the area of the square will $= a^2$,

area of the circle $= (3{\cdot}14159)\dfrac{a^2}{4}$; $\left(\begin{matrix}\text{3·14159 being the area of a}\\ \text{circle, radius 1.}\end{matrix}\right)$

$= ({\cdot}78539)\ a^2$,

$\therefore$ the area of the four corners, FBEG, &c.,

$= a^2\ (- {\cdot}78539)$,

$= a^2\ ({\cdot}21461)$;

and area of one of them $= ({\cdot}051365)\ a^2$.

Again, $EF^2 = AE^2 + AF^2 = \dfrac{a^2}{4} + \dfrac{a^2}{4} = \dfrac{a^2}{4}$, which is the area of the inscribed square, and is one half of (a^2), the circumscribing one; and any one of the triangles AEF will $= \dfrac{a^2}{8}$.

Again, the area of the triangle $AFG = \dfrac{AE.AF}{2} = \dfrac{a}{2} \times \dfrac{a}{2}$

and this divided by two, or $\frac{a^2}{8}$, as by the other method. These are given merely because of the pieces of wood making visible what is to be done.

The following offers a practical application of the 47th and other propositions in the first book of Euclid.

Imagine a line drawn from the eye of the spectator to the top of a tower, or any other object standing on a plain, and at right angles to it, and another from the same point parallel to the horizon, making an angle of 45°; then the height of the tower above the level of the eye is equal to the distance at which the observer is standing from the base; adding to this the height of the eye, would give the height of the object above the surface of the ground; if, when the observer takes his station, the angle is above 45°, he must recede from the tower—if less, he must advance—bringing to bear upon this the proposition "that the exterior angle of a triangle is greater than the interior and opposite." An approximation to accuracy in observing an angle of this kind may be made by making a sort of quadrant out of a piece of deal; holding one side horizontal, and looking along a line drawn from the centre through the middle of the arc.

At all events, this is sufficient to make boys understand the theory of it, and the object of this is obvious to make them reason, that—

If one angle of a triangle is a right angle, the other two taken together must be a right angle, because the angles of a triangle are 180°, or two right angles; if one of the two is 45°, or half a right angle, the remaining one must be the same—as the angles are equal the sides are equal.*

The particular propositions bearing upon this, the teacher will easily see.

In teaching them land-measuring, they should be made to understand on what principle it is that they reduce any field complicated in shape to triangles, squares, and parallelograms;

* A stick 5 feet 3 inches high is placed vertically at the equator, what is the figure traced out by its shadow during the 12 hours the sun is above the horizon? What is the length of the shadow, and of a line joining the top of the stick and the extremity of the shadow, when the sun's altitude is 45° and 60°? Work out the result in the latter case to four places of decimals.

why they make their offsets at right angles to the line in which they are measuring; to be able to prove the propositions in Euclid as to the areas of these figures, &c.; that a triangle is half the parallelogram on the same base and altitude, &c., and not to do everything mechanically, without ever dreaming of the principles on which these measurements and calculations are made.

Some time ago the observation was made to me, arising out of some boys having been seen to attempt carrying the above into practice: "Well, the worst thing I have heard of you lately is, that you are having trigonometry taught to the boys in the Somborne School."

This odd sort of compliment has often come across me, not knowing exactly what it could mean. I suppose those who make such observations do not mean that there is anything positively wrong in teaching *trigonometry;* but that it is wrong to teach it to that class of boys usually attending our parish schools. Now, one of the leading features of the school here, and, in my opinion, one of the most important, is, that it unites in education the children of the employer with those of the employed; and that to many children of the former class the elements of this subject may be most usefully taught, as applying to practical purposes connected with their after-life.

However, I have myself no objection that this or any other *ometry*, a knowledge of which may be likely to advance the interest and the civilization of mankind, half as much as trigonometry does, should be taught to promising boys in our parish schools, whose parents have been able to keep them there to a sufficient age, and have acquirements enabling them to learn it—these will be exceptions, and not the rule.

But why among the words, supposed to be of suspicious termination, attack the *ometries?* they, of all others, are the most harmless—dealing in weight and measure of an exact quantitative kind; so demonstratively true, that there is no chance of getting wrong—no possibility of there being *anti* anything whatever. There may be something of wrongness in some of the *ologies*, as they leave room for the wanderings of fancy, and do not deal in measured quantity as the *ometries* do. Here scientific men may, and perhaps sometimes do, become bold and speculative to a degree which may startle those

of a more sober-minded temperament, and who have not paid attention to the subject on which they treat; still, I think we may rest satisfied that where theories are advanced not based on truth, they will be but short-lived, and not do much mischief in the end.

Surely these objectors do not consider themselves as living in a railroad age—if they have ever travelled in the heavy Falmouth mail of olden times (for the distance between that time and this is, in social improvement, as regards locomotion, not a part of a generation, but whole centuries)—or if they have ever gone between Paris and Geneva in a French diligence without stopping, let them call this to mind, and they will no longer object to trigonometry.

As an instance of the force of meaning in a word when it once gets good hold on the public mind—happening to go to a book sale in my own neighbourhood, where there was a copy of an early edition of the Encyclopædia Britannica, when it was placed on the table for sale, a man, employed by one of the booksellers in London, rather drily, perhaps cunningly, observed,—"Why, you won't find the word railroad in it." Not another word was said; but after that I observed there was not a bidder besides himself.

MECHANICS.

The teacher should understand the more simple properties of the mechanical powers, and if not equal to the mathematical proofs of them, he should be able to show their application in the tools they are in the habit of using, and in many other things of common life—such as the common steelyard—turning a grindstone—raising water from a well by means of a rope coiling round a cylinder, and the nature of the momentum of bodies—what is meant by the centre of gravity, &c. A skilful teacher, with models of the mechanical powers to assist him, will make this a subject of great interest. For instance, in the lever, assuming the power multiplied the distance from the fulcrum equals the weight multiplied its distance, he might take a rod four feet in length and divide into feet and inches; at one end he fixes a weight, and placing the fulcrum at different distances from the weight, shows how the theory and practice agree, by actually testing each particular case, showing

that the calculated weight produces an equilibrium. This is a sort of proof by testing it in particular cases, and then by a process of induction assuming it to be generally true.

Then instance their own attempts at moving a block of wood or stone by means of a lever, placing the fulcrum as near the stone as they can, in order to gain power.

Boys balancing each other on a piece of wood over a gate, and adapting the length of the arms to their own weights.

Taking a spade, and supposing it to be pressed into the ground, and pulling at the handle in a direction perpendicular to it, the teacher asks where the fulcrum is—points out it must be the surface of the ground—the arm the power—the earth pressing against the spade the weight. Show if the power (the man's arm) is exerted at an acute angle with the handle, power is lost, part of it being employed in forcing the spade deeper into the ground; if at an obtuse angle with the handle, or an acute angle with the handle produced, power is again lost, part of it being employed in dragging the spade out of the ground; that pressing on the handle at a right angle is to work at the greatest advantage: this they perfectly feel from their own experience; also the necessity of having the spade of a substance specifically heavier than the handle.

The poker in stirring the fire—a pronged hammer in drawing a nail (the teacher drawing one)—the axe when they place it in a cleft of wood edgewise, and press upon the handle to make the opening larger—pair of scales, the steelyard—drawing water from a well by means of the windlass—the pump-handle, scissors, &c.

The knife—the blow of an axe in cutting down a tree—the coulter of the plough, &c. belonging to the wedge.

In the same way on the inclined plane when the power acts parallel to the plane, and taking for granted that the power is to the weight as the height of the plane to the length, or $P : W :: H : L$; any three of which quantities being given, the fourth may be found.

Then, for instance, knowing the height of the plane and its length, with a given power they will calculate what weight can be raised, or for a given weight what power must be applied.

It is in working formula of this kind, where a little algebra is required, and this with a knowledge of a few elementary

propositions in geometry, which the boys who remain longest at school are getting here, which gives a practical usefulness to their education, which is of great value.

The teacher should point out what an immense addition to human power all these mechanical appliances are, and besides these, others of a more striking kind, such as wind, water, steam, &c.

On this subject the following, taken from Babbage on the 'Economy of Machinery,' and given as an experiment related by M. Rondelet, 'Sur l'Art de Bâtir,' offers considerable instruction. A block of squared stone was taken for the subject of experiment:

	lbs.
1. Weight of stone	1080
2. In order to drag this stone along the floor of the quarry, roughly chiselled, it required a force equal to . . .	758
3. The stone dragged over a floor of planks required . .	652
4. The same stone placed on a platform of wood, and dragged over a floor of planks required	606
5. After soaping the two surfaces of wood, which slid over each other, it required	182
6. The same stone was now placed upon rollers of three inches diameter, when it required to put it in motion along the floor of the quarry	34
7. To drag it by these rollers over a wooden floor . .	28
8. When the stone was mounted on a wooden platform, and the same rollers placed between that and a plank floor, it required	22

From this experiment it results that the force necessary to move a stone along

	Part of its weight.
The rough chiselled floor of its quarry is nearly . .	$\frac{2}{3}$
Along a wooden floor	$\frac{3}{5}$
By wood upon wood	$\frac{5}{9}$
If the wooden surfaces are soaped	$\frac{1}{6}$
With rollers on the floor of the quarry . . .	$\frac{1}{32}$
On rollers on wood	$\frac{1}{40}$
On rollers between wood	$\frac{1}{50}$

From a simple inspection of these figures it will appear how much human labour is diminished at each succeeding step, and how much is due to the man who thought of the grease.

Care should be taken in introductory books containing formula to work from, the proofs of which the teacher perhaps does not understand, that the expressions are correct. I am led to make this observation from the following circum-

stance: when I first introduced this working from formulæ in the school here, I happened to go in one day when the boys were working out practical results between the power and weight of an inclined plane; this they were doing by taking the power to the weight, as the height of the plane to the length of the base, in the case of the power acting parallel to the plane; I was at a loss to conceive why master, boys, &c. should look so confident, even after I had pointed out to them the absurdity it led to in a particular case, instancing that if P : W :: H : length of the base, and $P = W.\frac{H}{\text{length of base}}$, when the base became nothing and the plane vertical, the power, instead of being equal to the weight, became infinite, the expression becoming $W.\frac{H}{0}$; but taking it as the length of the plane, when the plane was vertical, L and H were equal, and the expression $P = W.\frac{H}{\text{length of plane}}$ would become $P = W.\frac{H}{H} = W$, as it ought to be.

This I found arose from their having been reading a lesson on the inclined plane, and the error was, in the formula given in the note to the lesson: the confidence of the boys in the authority of the book, made it rather amusing to observe the shyness with which at first they received my explanation.

The great art in teaching children is not in talking only, but in practically illustrating what is taught; for instance, in speaking of the centre of gravity of a body, and merely saying it was that point at which, if supported, the body itself would be supported, might scarcely be intelligible to them; but showing them that a regular figure, like one of their slates, would balance itself on a line running down the middle, the length way of the slate, and then again on another through the middle of that, and at right angles to it, they see, as the centre of gravity is in both lines, it must be where they cross; and accordingly if this point be supported the body will be at rest—this they understand.

Again, balance a triangle of uniform density on a line drawn from one of its angles to the middle of the opposite side—the centre of gravity will be on that line—balance it

again on a line drawn in the same way from one of the other angles—the centre of gravity of the body will be in the intersection of these two lines.

In the same way methods of finding the centre of gravity of other regular figures mechanically might be pointed out.

The teacher should also make himself acquainted with the theory of bodies falling by the force of gravity—that it acts separately and equally on every particle of matter without regard to the nature of the body—that all bodies of whatever kind, or whatever be their masses, must move through equal spaces in the same time. This, no doubt, is contrary to common experience—bodies, such as feathers, &c., and what are called light substances, not falling so rapidly as heavy masses—smoke, vapour, balloons, &c., ascending; all this to be accounted for from the resistance of the atmosphere.

The spaces described by a falling body being as the squares of the times—that if it describes $16\frac{1}{12}$ feet in one second, in 2, 3, 4, &c. seconds it will describe 4, 9, 16, &c., multiplied into $16\frac{1}{12}$.

To show that while the spaces described in one, two, three, &c. seconds are as the numbers 1, 4, 9, 16, &c., those actually described in the second, third, fourth, &c. successive seconds are as the odd numbers 3, 5, 7, 9, &c., showing very strikingly the accelerated motion of a falling body.

To apply this also to the ascent of bodies projected directly upwards, with a given velocity.

Again, the moving force of bodies being equal to the mass multiplied into the velocity: How a small body, moving with a great velocity, may produce the same effect as a large body with a small one—as a small shot killing a bird—a large weight crushing it to death.

Interesting observations of a simple kind might be made on the strength of timber—weights suspended on beams between supports, such as the walls of a building—these coming under the principle of the lever, &c.; also such simple things as the following might be asked: Why is it easier to break a two-foot rule flatwise than edgewise; and why joists are now always made thin and laid edgewise?—which our forefathers did not understand. Although the reasons are sufficiently simple, very few even amongst the tolerably well educated can give a satisfactory explanation of them. The usual

answer, that it breaks more easily because it is thinner, will not do.

Wood, and all fibrous matter, is much stronger in the direction of the fibre than across it, and the strength varies as the square of the dimension in direction of the pressure, multiplied into the dimension transverse to it, when the length is given, or generally as the $\frac{\text{breadth} \times \text{depth}^2}{\text{length}}$.

It is a curious fact, but completely proved by experiment, that hollow tubes are stronger than solid ones of the same quantity of material—how beautiful this provision of Nature, as shown in the structure of the bones of animals, more particularly in those of birds and the larger quadrupeds, giving them the greatest strength, and encumbering them with the least possible weight.*

NATURAL PHILOSOPHY.

Nature herself seems to give a very instructive hint on this part of education, in the amusements of early childhood. We see a child as soon as it can use its hands, trying to move, or to lift anything which it can, placing it first in one position, then in another, and trying it in all the various ways which its senses admit of—in fact, making a variety of experiments with it, and this is generally looked upon as a mere amusement; but children when thus employed, are, as has been observed by Dr. Reid, "acquiring the habits of observation, and by merely indulging an undetermined curiosity, are making themselves acquainted with surrounding objects. If some new effect occurs from any of their little plays, they are eager to repeat it. When a child has for the first time thrown down a spoon from the table, and is pleased with the

* As a means of testing with accuracy and of forming some definite idea of the strength of the hollow stems of plants, &c., the following simple experiment, which I witnessed, by Professor Cowper, of King's College, London, is very instructive:

He placed a length of one inch of wheat straw in a vertical position in a hole bored in the lower of two parallel boards, held together by a hinge of the same height, one inch, and then brought down the upper board upon it. This he loaded with a load of sixteen pounds, without any appearance of breaking, and stated that he had known a straw bear as much as 35 lbs. placed in this position, before it broke.

jingling noise upon the floor, if another or the same is again given to him, he is sure to throw it down, expecting the same noise to occur; but if a piece of wood is given, he very soon finds out that the same effect does not take place, and is no longer anxious to repeat the experiment. So long as the noise goes on, the child has pleasure in repeating it, and if two objects are given, one of which produces a noise when thrown down in this way, and the other not, he very soon finds out the difference, and acts accordingly, and this is, in fact, the method of induction. The child is thoroughly persuaded that a jingling noise is sure to follow his throwing down the spoon, and goes on repeating it till he is tired."

"Such," observes the same philosopher, "is the education of kind Nature, who, from the beginning to the end of our lives, makes the play of her scholars their most instructive lessons, and has implanted in our mind the curiosity and the inductive propensity by which we are enabled and disposed to learn them."

It is an observation of the late Professor Daniel, in some of his works, "that the principles of natural philosophy are the principles of common sense," and from my own experience here in introducing this kind of teaching into the school, I am confident that, with those who have been able to remain to an age to profit from it, it has given an interest in what they are learning, and a kind of practical character to it, which no other teaching could give.

I recollect many years ago, going into a school in Germany, and a German gentleman, with whom I was, observed of something they were teaching, "das ist kein practicables ding," that is no practicable thing—the impression made at the time has remained on my mind ever since. We look upon the Germans, in some respects, as a people fond of theories, but at all events this was a sensible remark.

The following hints are intended to show to our schoolmasters, of the class for which this book is intended, the importance of being so far instructed in subjects of this nature, as to be able to point out, in a common-sense way, some of those results in science which bear more immediately on the occupations of life; these will be found not only interesting and instructive to the children while at school, but may be most useful to them after they have left it.

As a class, no doubt at the present day the far greater

number of our schoolmasters are not qualified to give this instruction, but there are many, and that number, I hope, increasing, who are;—to such, although the following pages may not add much to their knowledge, they may perhaps suggest something in the way of imparting it, and in bringing it to bear upon their teaching. They will also point out to others some things with which they may easily make themselves acquainted, and a few simple experiments which are easily tried.

Among the more striking of these things will be such as the following: the elastic and other properties of air—the nature of aeriform fluids—of water—how the pressure of fluid bodies differs from that of solids—how these properties enable man to turn them to useful purposes, such as windmills, watermills, &c.

Civilized man is able to take advantage of these properties, and avail himself of them as motive powers in the business of life; the savage, on the contrary, observes the trees torn up by the winds, stones and rubbish carried down by mountain torrents, but is unable to turn this observation to any useful purpose.*

And first, of the atmosphere—a sphere of air surrounding the earth—has substance and weight, but is invisible—elastic,

* Archbishop Whateley, in his 'Introductory Lectures on Political Economy,' observes: "Many of the commonest arts, which are the most universal among mankind, and which appear the simplest, and require but a very humble degree of intelligence for their exercise, are yet such that we must suppose various accidents to have occurred, and to have been noted—many observations to have been made and combined—and many experiments to have been tried—in order to their being originally invented.

"And the difficulty must have been much greater, before the invention and the familiar use of writing had enabled each generation to record for the use of the next, not only its discoveries, but its observations and incomplete experiments. It has often occurred to me that the longevity of the antediluvians may have been a special provision to meet this difficulty in those early ages which most needed such help. Even now that writing is in use, a single individual, if he live long enough to follow up a train of experiments, has a great advantage in respect of discoveries over a succession of individuals; because he will recollect, when the occasion arises, many of his former observations, and of the ideas that had occurred to his mind, which, at the time, he had not thought worth recording. But previous to the use of writing, the advantage of being able to combine in one's own person the experience of several centuries, must have been of immense importance; and it was an advantage which the circumstances of the case seemed to require."

can be squeezed into a less space by pressure—expands again when the pressure is removed—expands by heat and contracts by cold. This may easily be made intelligible to them in the following way:

Take a tumbler and invert it—or better, take a jar used for gases, with an air-tight stopper, and placing its mouth horizontally on the surface of the water, in a pneumatic trough, or in any vessel of sufficient depth, having a shelf for support, show them, by letting them feel it, the difficulty of pressing the jar down—it offers resistance—increase the pressure, the air occupies less and less space, but the water inside the glass does not rise so high as on the outside;—difference owing to what?—point out. Diminish the pressure, it again expands, showing its elasticity. Of course the attention of the children must be called to the surface of the water inside and outside the jar.

Take out the stopper, the jar sinks by its own weight, proving clearly that the resistance was offered by the air.

Again, allow the jar to fill with water, put in the stopper, and raise the jar nearly to the surface of the water in the trough—explain why the column of water is supported, and would be supported if the jar were 33 feet high at the ordinary pressure of the atmosphere—take out the stopper, the water immediately falls;—or while the column of water remains, show how the jar may be filled with air, by carrying down successive tumblers of it until the jar is filled.*

From this the method first used of taking down barrels of air into a diving-bell is easily understood.

Air expands by heat. Experiment: a half-blown bladder placed before the fire, the wrinkles disappear, the air expanding it; remove it, the air again contracts.

Place the same under the receiver of an air-pump, it expands from diminished pressure.

Air has weight. A bottle exhausted of the air is lighter than when full—difference, the weight of a volume of air equal to the contents of the bottle—this means air at the ordinary temperature and pressure of the atmosphere—100 cubic inches dry pure air weigh 31·0117 grains, being for a cubic yard 4½ oz. Balance the bottle when full of air at one

* Why is it necessary to have a vent-peg in a barrel—or how does it happen that the teapot sometimes will not pour? &c.

end of the scale-beam; then take it off and exhaust it by means of the air-pump, and when again suspended, the other end of the beam will preponderate; restore the equilibrium by pieces of paper, &c.

Drinking through a straw. The teacher, taking a straw and a basin of water, shows them, if the mouth or orifice of the straw is not wholly immersed, or under water, the water will not rise; wholly covered—when they begin to draw out the air the water immediately rises, and why?—What takes place if a hole is made in it above the surface of the water? Water does not rise.—What if you plunge it deeper, so that the hole made in the straw is below the surface?—It immediately rises again.—Reasons for all this, which, if they comprehend, they will at once understand the barometer, and common pump.*

Again, a piece of wet leather with a string attached, called a sucker;—press it with the foot against a stone—remove the air between the leather and the stone,—leather, say a square piece three inches on a side, ought to support 9 × 15 pounds, only supports, say 80lbs.—reason why? The vacuum not complete. Then take a circular piece, three inches diameter, let them find the area, and calculate how much it ought to support. This is the principle on which a fly is able to walk along a pane of glass, or across the ceiling.

The common syringe. The popgun they are in the habit of making out of a piece of the elder tree—how, by pressing down the rod, the elasticity of the air forces out the pellet at the other end; when they cease to press the rod of it down, the elasticity of the air within forces it back.

A pair of common bellows. Show them the construction—the valve, or trap-door in the bottom board, opening only inwards—the bellows fill with air when the boards are separated—valve shuts down, and the air goes out at the nozzle when they are pressed together—will not work when turned upside down, why?—the current of air makes the fire burn better;—the reasons for all this. The teacher should have a pair of bellows, and show what takes place at each movement of the board, and let them handle them themselves.

The barometer. The teacher shows them the instrument,

* A model of a common pump with a glass cylinder will be found a very instructive piece of apparatus. See Appendix—List of Apparatus.

how constructed, and what it is for;—pressure of the air supports a column of mercury about 30 inches—a column of water about 33 feet—the height of the column being less in proportion as the specific gravity of the fluid is greater—not so high if carried to the top of a mountain,* and why?—temperature at which water boils varies with the height of the barometer—boils at a less heat on the top of a mountain than at the bottom. The mode of ascertaining the height of mountains by means of the barometer.—Why this method is more to be relied on in tropical climates than in high latitudes, &c.

The principle of the common pump might now be explained to them—how the atmospheric pressure which supports the mercury enables them to pump up water—having a model of a pump, or even with paper and pasteboard, showing the kind of tubes and nature of the valves, this may be clearly explained—pointing out how the valves act at each separate movement up and down of piston-rod—the limit to which water can be raised—the experiment of Torricelli, &c.

Supposing the atmospheric pressure about 15lbs. on the square inch—how much on five square inches?—how much on five inches square?—on a square three inches on a side?—on the surface of the floor or the table?—making them have recourse to the two-foot rule;—pressure on the animal body, &c., and how counteracted. A fish under water has the pressure of the air, 15lb. on a square inch, besides the pressure from its depth in the water;—a basin of water with a live fish in it, when placed under the receiver of the air-pump and exhausted, the air-bladder expands, and the fish turns on its back.

Children may easily be made to understand that the atmosphere is an aeriform fluid surrounding the globe, acted on like other bodies by the force of gravity, consisting principally of two airs or gases, varying in weight, and partly of a third, heavier than either of the others, but if placed upon each other in the order of their specific gravities, the heaviest nearest the surface of the earth, next heaviest in the middle, and the lightest at the top, that they would not remain in this order of superposition, as, for instance, the three fluids, quicksilver,

* Pascal, in France, about the year 1647, was the first to make this experiment, which he did at the summit and foot of a mountain in Auvergne, called Le Puy-de-Dôme, the result of which led him to conclude that the air had weight. He also tried it at the top of several high towers, which convinced him of the weight of the atmosphere.

water, and oil, would do; but the heavy one at the bottom would rise up and travel through the pores of the other, and the lighter one would descend, this being a property peculiar to bodies of this nature, and called the diffusion of gases. That, in addition to this, there is an atmosphere of vapour of water, arising from evaporation from the surface of the earth and of water, and which is in itself lighter than dry atmospheric air; a cubic inch of water at the common atmospheric pressure forming about 1700 cubic inches of vapour; therefore a cubic inch of vapour of water is about $\frac{1}{1700}$ of the weight of a cubic inch of water—a cubic inch of common atmospheric air about $\frac{1}{800}$.

Having called their attention to the fact that a substance lighter than water will, if plunged into it, rise to the top; that of two fluids the lighter will rest upon the heavier; arranging themselves according to their specific gravities—as water upon mercury—oil upon water—cream upon milk—they will easily understand why bodies lighter than air ascend in it, as the smoke from their chimneys—tell them to watch it, particularly on a still calm day—why it ascends to a certain point, and then stands still—why it stands still and does not rise higher; the principle on which a balloon ascends, a soap-bubble, &c.

Again, why there is a draught up the chimney;—the air rarefied, how this takes place;—why a current of air under the door and towards the fire—and another perhaps out of the room at the top of the door?

The kind of resistance offered by the air to a falling body—this increases with the density—that under the receiver of an air-pump, a guinea and a feather would fall at the same time.

As a simple experiment, showing the effect of rarefaction of air, the teacher might light a piece of paper, and while burning place it in a teacup, and invert the cup in a saucer of water—the water will immediately be driven into the cup with a gurgling noise.

Again, the practice which cooks have of putting an inverted teacup in a fruit pie, as they think with a view to prevent the syrup running over, as the pie bakes, the air in the cup is rarefied, driven into the pie-dish, through the crust, into the atmosphere—when taken out of the oven it cools, the rarefied air in the cup is condensed, but as the mouth of the cup is

surrounded with the juices of the pie, air cannot get into it, but it forces the liquid up.

The teacher explains why the resistance of the air in moving along is so little felt—some of the consequences of its being disturbed, and causes of its being put in motion—a breeze, a hurricane, &c.; he would also speak of the forces of these at different velocities—the force varying as the square of the velocity. This short table might be the subject of a lesson:

Velocity of the wind in miles per hour.	Perpendicular force on one square foot in pounds.	——
5	·123	Gentle wind
10	·492	Brisk gale.
20	1·968	Very brisk.
40	7·872	High wind.
80	31·488	Hurricane.

It will be easy to calculate the force of the wind acting on a given surface, doing so in particular cases will be instructive.

Tell them they may form an idea of the velocity of wind by watching the shadows of clouds, or the clouds themselves, and if ever they should travel by railroad on a sunny day, to observe the shadow of the train as it passes over one field after another, and from this they may form some idea of the speed at which they are travelling.

Air as a vehicle of sound:

A bell under the receiver of an air-pump when exhausted, is not heard.

Bodies which produce the sensation of sound on the ear are in a state of vibration, as in a bell—the running a wet finger along the rim of a common drinking-glass, &c.

Here having to do with the instruction of children engaged in country occupations, I have called their attention in this, as in other subjects, to things coming under their observation, in a way something like the following:

Did you ever observe a woodman cutting down a tree at a distance; you could see the hatchet fall, and some time after that the sound of the blow came to your ear. Do you know the reason?*

Teacher: Light travels so fast that the time it is in coming

* See Appendix (B).

from the hatchet to you is so small that it cannot be reckoned; so that when you see the hatchet fall, that is the instant the blow is given; but sound, coming at a very slow pace (1142 feet in a second), takes as many seconds to get to your ear as when multiplied by 1142, would give the number of feet between you and the man cutting down the tree.

For instance, if it were 2″ his distance would be 1142ft. $\times$ 2, if 3″ 1142 $\times$ 3, and so on.

Did you ever see a man firing a gun at a distance, and, after seeing the flash, wondered why you did not hear the sound, or that you were kept considering how long it would be before the sound came? Do you know the reason—can you explain it? Because sound lags behind, and the flash takes up no time in coming to the eye.

Supposing you were 5″ before you heard the sound after seeing the flash, how far would you be off?—5 $\times$ 1142; 6″, how far?—6 $\times$ 1142, and so on.

When we hear the Portsmouth guns here, if you could have seen the flash, do you think you could find out the distance between this and Portsmouth?

Supposing a man was standing where you could see him a mile off, and you saw the flash of his gun, how long would it be before you heard the sound? A mile in feet divided by 1142 would give the number of seconds before I could hear the sound.

Teacher: How do you think the sound gets to your ear? The air in the gunpowder suddenly expands and disturbs the air immediately about it, or the hatchet causes a vibration or tremulous motion in the wood, which sets the air in motion all round about; and this makes a sort of circular wave, beginning from a point which gradually enlarges, one circle of the air of the atmosphere striking against another, until it reaches the ear, unless it meets with some hinderance in the way; just as when you throw a stone into a smooth pond, a wave, beginning from the stone spreads in every direction, until it reaches the bank. The air is as necessary to continue the sound up to your ear as the water is to make the wave come up to the bank.

Sound goes much quicker in water—nearly four times as quick as in air, and in solids from ten to twenty times quicker; so that if you splash in the water at one end of a pond, the fish would hear you much sooner than a boy standing at the opposite side would do.

Now, in order that you may understand how well solids convey sounds, the next time you see a solid log of deal, or timber not very knotty and broken in the grain, at the carpenter's shop, set one of the boys to scratch at one end of it, and the rest of you go and listen at the other. Try the same on a block of stone, marble, &c.

But perhaps this will amuse you more: when you see the kettle on the fire, and you cannot tell whether it boils or not, place one end of the poker on the lid, the other to your ear, and it will tell you. If you strike with a hammer on a solid wall at one end, and some of you go and fix your ears against the other, you will most likely hear the sound of the blow twice—the first going along the wall you may call the wall-wave (coming more quickly), the second, a little after, through the air, coming with the air-wave we have talked of before. Try if you can hear two reports of the same knock by tapping with a hammer at the end of a log of wood—one along the wood, the other along the air.

You have heard of the wild natives of America—when they think their enemies are near, they lie down on the ground, and, by applying their ears to it, they can judge of the distance, and hear sooner than through the air.

Did you ever hear what is called an echo?

Supposing you were to clap your hands violently together, that creates a wave in the air which carries the sound along with it; now, if this wave happens to meet with a wall or a rock, or any obstacle in its way, it is checked and beat back, and so brings the sound with it a second time to your ear; and again, after passing you, if it met with the same sort of obstacle on the other side, it would be sent back again, and so strike your ear in passing and repassing, losing a little every time until it entirely died away. This would be called an echo; people living in a flat country have not so many opportunities of observing it as those who inhabit a craggy and mountainous one.

Water—a fluid at the common temperature of the atmosphere. Have you ever seen it solid? In winter—in frost—it is then ice.—How high does the thermometer stand when water begins to freeze? 32°.—Look at the thermometer in the room, how high is it? 52°.—How many degrees above the freezing point?—Does it increase in volume when it be-

comes ice? Water from the temperature of about 39°, expands as it grows colder, and at 32°, when it becomes ice, expands so as to crack water-bottles, water-pipes; a piece of ice floats in water, part of it being above the surface; if it were of equal weight with the same volume of water, it would just sink so as to have no part above.—You should never let water stand in leaden pipes, or in vessels likely to be broken by its freezing in severe frosts. This expansion of water in becoming ice, how serviceable to the farmer, in some soils, in pulverizing and making themfit for vegetation—good for gardens, &c.!*

Quicksilver, unlike water in this respect, contracts and becomes denser in becoming solid. It has been ascertained by leaving it exposed to the cold in high latitudes, where it has assumed a solid form, and observing the temperature at which it begins to thaw, that the freezing point is about 40° below zero of Fahrenheit.

Attention may be called to the way in which the roads are raised up in winter by the feeezing of the moisture within them—how after a thaw a loaded cart or waggon sinks in, causing deep ruts—how rocks and stone, which have absorbed much moisture, split after frost—parts of buildings peel off, &c.

Can water be made into a vapour—something you cannot see? By heat it becomes steam, thermometer 212° at the average pressure of the atmosphere; one inch of water makes about a cubic foot, 1728 inches, if further heated it exerts a greater pressure in trying to escape, pressing on the surface of the vessel in which it is. This is the property which makes it so serviceable to us in grinding our corn, moving the machinery for spinning and weaving, of steam-boats, &c. and as a motive power on our railroads, carrying us forty or fifty miles an hour. If cooled below 212° it immediately falls back, shrinks

* "That water contracts in reducing the temperature to about 40°, and below that again expands, is easily shown, by taking two equal thermometers, the one filled with water and the other with spirit; placing them in melting ice, the spirit one will gradually fall to the freezing point, but the other will fall to about 40°, and then begin to rise. By Act of Parliament the temperature at which the specific gravity of spirits is determined by the excise, and at which the standard weights and measures is adjusted, is 62° of Fahrenheit."—Daniel's *Chemical Philosophy.*

up into one inch, and becomes visible water again, giving out a great deal of heat;—instance steam raising the kettle-lid.

Why does the teakettle just before boiling very often force out a quantity of water from the spout? Because the air, driven from the water by heat, and the steam which is forming from the water rise to the top, and the lid happening to be air-tight, it cannot escape, and being lighter than water it cannot descend, so the vapour or steam under the lid increases and expands, and, pressing upon the surface of the water, forces it out at the pipe.—Did you ever see on a frosty day, when you were going with a team, what you call the breath of the horses, or your own breath? Yes, sir.

Teacher: The warm air from the horses' mouths, or from your own mouth, containing vapour which you cannot see when the air has a certain degree of warmth in it, as soon as it comes in contact with the colder air gets cooled, and the steam or vapour becomes water (is what they call condensed), or perhaps watery vapour, which you can see, instead of a vapour which you could not see.

Did you ever see sugar or salt melted in water? No, sir; but we have seen sugar in tea.—Then the teacher takes a small phial containing water and puts in a certain quantity of salt, when entirely melted they see the fluid perfectly clear; increase the quantity beyond what the water will take up, this remains undissolved; if the temperature of the water were increased it would take up more; in the same way the air will take up a greater quantity of vapour the warmer it is, and coming from the mouth warm, it holds more vapour than it is able to do, when it comes in contact with the cold air, and throws some of it down, so that you can see it; thus water on the inside of the window in frosty weather—dew on the outer surface of a bottle of cold water in hot weather, &c.—the quantity of watery vapour in the air in hot climates greater than in cold, hence torrents of rain when it is suddenly cooled, &c.

About London, latitude 51° 30′, the average fall of rain in the year is about 23 inches; while in Rome, latitude 41° 54′, it is 38 inches;* at Calcutta, latitude 22° 34′, it is 81 inches;

* By inches of rain is meant the depth at which it would stand on every square inch of surface on which it falls, supposing none to be absorbed by the soil or to evaporate.

and in climates like the West Indies upwards of 100 inches; but though the quantity of rain falling in hot countries is greater than in the temperate ones, the number of wet days is greater in the latter than in the former; there is more moisture in the air in our climate in summer than in winter; but from the greater temperature it is held up, and is not so sensible to us.

Two fluids in the same vessel, one lighter than the other, which would get to the bottom? The heavier one.—Give instances. Milk and cream, water and oil, quicksilver and water, water and air.

The teacher, holding up a glass: What is this glass full of? Atmospheric air.—If I pour in water, what does that do? Drive out the air, because it is the heavier fluid?—If I pour quicksilver into a glass of water, what would take place? The quicksilver would drive out the water for the same reason.—If water upon mercury, or oil upon water? The water or oil, being the lighter fluids, would rest on the top, and the same thing would take place if carbonic acid or any gas heavier than air were poured in.—Another instance: fill a small phial with water, leaving room for a bubble of air, and then cork it; holding it in a horizontal position the bubble rests in the middle, elevate one end, the bubble rises to the top; show how this may be used as a spirit-level.

Look at that cubical vessel on the table, divided into two equal parts by a division in the middle. Suppose one division full of mercury, the other of water, and the partition suddenly withdrawn, what happens? The mercury immediately covers the bottom of both parts, and the water rises to the top.

Take a bottle of water from a cool spring or from the pump; place it in the sun or in a room—for instance, as you see it sometimes in a bedroom. You will observe air-bubbles form themselves on the surface of the glass—at the bottom and the sides—this is air contained in the water. As it takes the temperature of the room these air-bubbles form themselves, expand as they rise, come suddenly to the top, the water being of equal temperature throughout. Why does the bubble expand as it rises? The pressure upon its surface varies as the depth, and therefore the nearer the surface the less the pressure.

How is it, then, if you place water in an open saucepan on the fire to heat, we see at first bubbles form themselves at the bottom, like pieces of glass, rise up a little way, and then lost before coming to the surface?

The air in that part of the water in contact with the bottom of the saucepan, immediately it begins to feel additional warmth, forms a bubble, rises up a little way, and although the pressure is diminished, it becomes again compressed, in consequence of coming in contact with cooler water as it rises. This it is, I believe, which causes what is called the hissing of the kettle.

If you were to boil a quart of water until it has all, as you call it, boiled away, what has become of it?—All turned into steam.—If water with salt or chalk in it?—The water would go into vapour, and the chalk or salt left behind, at the bottom of the kettle.

Did you ever see a white crust at the bottom of your tea-kettle?—Yes, sir; but we don't know what it is.—Don't you know we live upon what is called a chalk soil here, and the rain that falls makes its way through the chalk and comes out underneath it, having taken up some of the chalk in its way through. If our hills had been of iron ore, lead, or salt, the water would have taken up some of these substances in passing through them, as it always takes up some of the earth through which it filters—as it is a fluid in which many things are soluble; thus, we get water with chalk in it—when you boil it, the pure water goes off in vapour, and leaves the chalk behind, which falls to the bottom of the kettle: besides this, although hot water will hold up or melt more sugar or salt than cold, yet it will not hold more chalk, on the contrary less, as the heating drives off a particular gas or air (called carbonic acid gas), which has a great liking for the chalk, and holds it up in the water, so that what falls to the bottom partly belongs to the water which is driven off, and partly to that which is left in the kettle. These are two reasons therefore why your kettle has a white mass of chalk at the bottom.

Taking off the lid of a kettle when the water is boiling, turning it up, what do you observe? Drops of water. These are formed by the steam coming against the lid, cooling it down so that it becomes water—the lid being in contact with the atmosphere conducts off the heat from the steam—this is distilled water or pure water, containing no lime, salt, &c.

Two fluids mixed together, which become vapours at different temperatures, may be easily separated—thus a mixture of spirit and water; heat the mixture up to the temperature at which spirit becomes vapour, it goes off and may be collected, the water remaining behind.

That the boiling point of water or any other fluid varies with the atmospheric pressure—how this may be applied to find the altitude of mountains—that water at the top of Mont Blanc, for instance, boils at a temperature of about 187°—that a difference of 1° in the boiling-point corresponds to about 530 feet of ascent,* and this difference in boiling will denote a fall of about 0·589 inch of barometric pressure—that, under the receiver of an air-pump, water may be made to boil at a very much lower temperature than in the air. This and other things of a similar kind I find, from experience, may be made most instructive and useful to them, and more particularly if a school is provided with a philosophical apparatus with which the experiments can be shown. A table of the temperatures at which different fluids boil and freeze should be suspended on the wall.

Heat water to boiling in a Florence flask, cork it well when boiling, and turn the flask upside-down, having removed it from the lamp it now ceases to boil; sprinkle water on the surface of the bottle, the steam within is condensed, and it again begins to boil; when it again ceases to boil, from the elasticity of the steam within, repeat the sprinkling, and it commences boiling again; thus the application of cold makes the water boil.

The different ways in which water and metals are heated—hot current ascending, the cold water descending, and metals from particle to particle; point out also the difference in the process, in attempting to heat water by placing the fire above and not under the vessel containing it. The conducting power of fluids is very small, and it has been found that water may be made to boil in the upper part of a tube, without imparting much heat to the water below it, and that it may be brought to the boiling-point within one fourth of an inch of

* Archdeacon Wollaston invented an apparatus of such delicacy for ascertaining this, that the difference of the height of a common table from the ground would produce a difference in the boiling-point, which was clearly shown by the instrument.

ice without its immediately melting; and that ice is melted eighty times slower when it is fixed at the bottom of a cylindrical vessel with water above it, than when it floats upon the surface of warm water.

Salt is got from sea water by exposing it to the air in large pans; the water goes off in vapour and leaves the salt behind; the greater the surface exposed to the air the more rapidly the water goes off. Shallow pans better than deep, and why: Do you not observe the water lessen very much in summer in your sheep-ponds, even when you do not take cattle to drink at them? It is taken up by the air; in the same way a good brisk wind dries rapidly the hay, corn, clothes after washing; and if you want anything that has been washed to dry fast, you unfold it as much as you can in order to expose all its surface to the air. For the same reason you spread out the grass and leave the corn in the field, in order that the fluid matter contained in them may be taken off.

Salt also is found as a mineral in Cheshire, Poland, &c.; and salt-springs are very often found in the coal-mines in some districts, particularly in Durham and Newcastle, where a great part of the salt used by the miners for their own domestic purposes is supplied by the salt-springs in the mines.

The following is an easy instructive experiment: Take a small quantity of rock-salt and also of saltpetre, the crystals of which differ very much, dissolve them together in water, they form a clear limpid fluid. Pour this solution of the two into a small dish and let it evaporate; crystals of pure salt and saltpetre will be the result, the beautiful long crystals of saltpetre being totally devoid of salt. This shows clearly that the atoms of salt have an attraction for and seek for their own atoms—the same of the saltpetre, and that if there is any attraction of the one for the other, it is less than that among themselves.

Dew. When it is once understood that the air of the atmosphere holds up a considerable quantity of vapour, and that the greater its temperature the greater is the quantity which it holds, it will be easily understood that, when any portion of air comes in contact with a body colder than itself, that it will throw down some of its moisture.

During the daytime the earth, plants, &c., absorb heat from the sun; when he goes down they radiate or give off part of

the heat they have absorbed, and consequently cool;—this cools the air in contact with them, and when cooled below the point which enables it to hold up all the vapour which it had taken up during the day, it lets it fall again—this is called the dew-point. Now, some plants and some leaves, and earths give off heat faster than others—on such a more copious dew will be deposited. On the contrary, gravelled walks, stone, &c. give off heat less rapidly, and on them little or no dew falls.

This all know from experience, or at least may easily ascertain it:—then to call their attention to the beautiful drops of dew formed on the leaves—the service they are to the plants—the beautiful provision of the Almighty in causing the dew to fall more copiously on the vegetable world, which wants it, than on the mineral—attraction of cohesion keeping the globules together, &c. Why they disappear in the morning, again becoming vapour.

Any schoolmaster taking an interest in this subject, will see some very simple but curious and instructive experiments in Griffiths's 'Chemistry of the Four Seasons.' They consist in taking equal portions of dry wool of a given weight, and placing them in the evening—one on gravel, another on glass—another on grass, but sheltered by a slight covering a little elevated above it, and then at sunrise taking them up and weighing them; of course the increased weight, which will in all these positions vary very much, is the weight of water deposited in the shape of dew. These and a variety of phenomena connected with this subject, easy of explanation—such as the mists—the fogs rising in damp, marshy places—following the course of a river, and many appearances of a like kind, which those living in the country are in the habit of witnessing, may be studied with great interest; but, as it is merely my object to throw out what I conceive to be useful hints, I will not pursue it further.

The force with which the absorption of moisture by porous bodies causes them to expand is much greater than those who have never thought on the subject have an idea of.

As an instance of this, and of turning it to practical purpose, Sir John Herschel, in his 'Discourse on the Study of Natural Philosophy,' gives the following very interesting one, as a process which is had recourse to in some parts of France where millstones are made: "When a mass of stone suffi-

ciently large is found it is cut into a cylinder several feet high, and the question then arises how to subdivide this into horizontal pieces, so as to make as many millstones. For this purpose horizontal indentations or grooves are chiselled out quite round the cylinder, at distances corresponding to the thickness intended to be given to the millstone, into which wedges of dried wood are driven. These are then wetted or exposed to the *night dew*, and next morning the different pieces are found separated from each other by the expansion of the wood arising from its absorption of moisture."

This is a very curious instance of a simple natural power doing what would require great trouble and expense to effect; either by chiselling through, or by any machinery of sawing, sometimes used for dividing blocks of stone. The same author also mentions another instance where a knowledge of the laws of nature, although acting here in a different way, is called into action. In this case the heat first expanding, and then the application of the water causing a sudden contraction. In the granite quarries near Seringapatam the most enormous blocks are separated from the solid rock by the following neat and simple process. The workmen having found a portion of the rock sufficiently extensive, and situated near the edge of the part already quarried, lay bare the upper surface, and mark on it a line in the direction of the intended separation, along which a groove is cut with a chisel, about a couple of inches in depth. Above this groove a narrow line of fire is then kindled and maintained till the rock below is thoroughly heated, immediately on which a line of men and women, each provided with a potful of cold water, suddenly sweep off the ashes, and pour the water into the heated groove, when the rock at once splits with a clean fracture. Square blocks of six feet in the side, and upwards of eighty feet in length, are sometimes detached by this method.

The following practical way of giving an insight into the principle on which bodies float in fluids lighter than themselves, and of estimating their weight by the quantity of fluid displaced, has been found very serviceable:

They have two tin vessels, a larger and a smaller one, the large one having a small spout level with the top, so that, when filled with water and running over, it may discharge itself into the small vessel placed by the side of it: the small

one of known dimensions, say nine inches square at the bottom and six inches high, with a graduated line on one of the sides, so that it may be immediately seen to what height the water rises when flowing into it, and of course knowing the area of the base, and multiplying this into the height at which the water stands, will give its volume.

Then they are provided with a number of cubes of wood, the woods of the parish, oak, elm, ash, &c., four inches on a side—together with other pieces of any irregular shapes, for the purpose of experiment.

Having filled the larger vessel with water up to the spout, and placed the smaller one under it, the teacher takes a cube of oak, for instance, floats it on the water, which immediately begins to flow into the smaller vessel, and when it has ceased to do so, the height at which it stands is observed. They then calculate the number of cubic inches of water displaced.

This they know is equal to the number of cubic inches of oak under water—(the teacher should show them the proof of this)—that it is equal in weight to the piece of oak—(proof) —then knowing that the weight of a cubic foot of water, temperature about 62°, is 1000 ozs., and why it is necessary to specify the temperature—they calculate, for instance, the weight of a cubic inch, by dividing 1000 by 1728, the number of inches in a foot.

Then multiplying the weight of one inch by the number of inches, this gives the weight of water displaced, and the weight of the wood.

They then take the piece of wood, tie a string round it, weigh it by a spring-balance, and find this exactly agrees with the figures they have worked out; and it is this weighing which gives such a character of certainty to what they have been doing, which makes them take pleasure in the work. Weighing before floating it is better.

Again, knowing the measurement of the piece of wood, supposing it to be one of known dimensions, subtracting the number of solid inches under water from the whole, gives them that part of the body above the surface, and which is floating in air.

The same would be done with pieces of ash, elm, fir, &c.

Also in winter, pieces of ice afford a teacher who understands the subject an opportunity of giving a useful lesson—pointing out how water becomes solid at a particular temperature—that although water freezes at this particular point, yet pieces of ice may have a temperature far below this—that a piece of ice, temperature 20°, as measured by Fahrenheit, would be of more service for cooling butter, water, &c., than one at 32°, and so on.

The teacher might ask such a question as, What is the atmospheric pressure on the surface of the water in the vessel? making them calculate it, and showing how it varies with the barometer.

It is by repeating these questions over and over again, in a practical way, that they tell on the minds of children.

Again, take a small square, or oblong, or a box of any shape—a piece of wood hollowed out like a boat—a tin, such as tarts and bread are usually baked in: floating these, and loading them with weights until the water reaches the edge—they then see clearly that the quantity of water displaced is equal to the measure, in volume, of the vessel and the material of which it is made: and that a boat will just float, when the weight of the cargo and the weight of the boat taken together are equal to this displaced volume of the fluid in which it floats, and that any weight beyond this will sink it.

Calculating the weight of this volume of water displaced, and subtracting from it the weight of the boat, gives the extreme weight which the boat would carry without sinking.

Applying this to boats made of iron, or any other heavy metal, it is evident, that so long as the weight of the boat is less than a weight of fluid on which it is floating, the volume of which is equal to the whole size of the boat and material included, it will carry some cargo—that the limit to the thickness of the iron, so that the whole may float, is that which would make the weight of the boat equal to the weight of fluid of its own volume—that the thinner the material (due regard to safety being had), as in all cases the less the weight of the boat itself, of a given size, the greater cargo it would carry—that a boat which would sink in one fluid, would float merrily in another which was heavier, &c.; for instance, a load which would sink in fresh, would float in salt water, and be

buoyant in mercury. The teacher would naturally point out that the same boat would carry a heavier cargo on salt water than on fresh. What would it be on oil, milk, mercury, &c.?

The number of things which the principles connected with floating bodies may be called upon to illustrate is very great.

It may be well also to point out that a floating body is stable, when a line joining the centre of gravity of the body and that of displaced fluid is vertical.

Having made them understand what is meant by the term specific gravity, and that by taking the weight of a certain volume of water as a standard, we calculate the weight of other bodies, it will be well to have a table of the specific gravities of substances in common use, metals, woods, &c., suspended on a card in the schoolroom; and to show them by experiment how these results are arrived at. It is quite a mistake to think that boys about twelve or thirteen years of age cannot be made to understand them, and not only that— they will take a great interest in them.

A short list is added, merely for the purpose of working an example or two from it. Taking water as 1.

Distilled water	1·	Copper . . .	8·788	Coal . .	1·250
Sea water is .	1·026	Tin	7·291	Oil . .	·940
Platina . . .	22·069	Iron (cast) .	7·207	Oak . .	·925
Gold . . .	19·258	Iron (bar) .	7·788	Ash . .	·845
Mercury . .	13·586	Zinc . . .	7·100	Maple .	·755
Standard silver	10·474	Flint glass .	3·329	Elm . .	·600
Lead . . .	11·352	Marble . .	2·700	Fir . .	·550
Brass . . .	8·396	Ivory . . .	1·825	Cork . .	·240

A simple inspection of this table may be made a useful lesson, by pointing out to them the comparative weight of those substances they are continually handling, the difference among them being much greater than they are in the habit of thinking it—that those substances the specific gravity of which is less than 1 will float. In this way the comparing one thing with another makes them think. Also why distilled water is a standard—that water varies in weight with the substance it holds in solution—that its boiling-point varies with these substances.

Assuming the weight of a cubic foot of *distilled* water, and at the temperature of 63° Fahrenheit, to be 1000 ozs., (why distilled water, and why a fixed temperature?) let them

show that the weight of a cubic inch $= \frac{1000}{1728}$, and why the divisor is 1728.

When we speak of the specific gravity of lead being 11·352 and of iron 7·788, we mean that the weight of any given volume of lead or iron will be so many times that weight of the same volume of water, and knowing the one, the other is easily calculated.

Thus a cubic foot of water weighs 1000 ozs., therefore a cubic foot of lead weighs 1000 ozs. $\times$ 11·352 = 11352 ozs., of iron 1000 ozs. $\times$ 7·788, or 7788 ozs., of an inch in the same way.

The specific gravity of dry oak is ·925, of fir ·550, of elm ·600, therefore any given volume of these woods would float, being lighter than the same volume of water. A cubic foot of dry oak would be 1000 ozs. $\times$ ·925, or 925 ozs.; of fir 1000 ozs. $\times$ ·550, or 550 ozs., a little more than half the weight of oak.

As applied to these substances, a good deal depends on their state of dryness, sap in them, &c.

The following questions of a practical kind may suggest others:

What is the weight of a block of marble, granite, &c., of regular figure (or any other which they can measure), base of it fifteen feet six inches by five feet two inches, and four feet high.

A given number of feet of oak, elm, ash, &c.? A given mass of metal, what would be its weight? The weight of metals is exactly known from measurement, supposing them to be pure.

In this way they will easily see what horse-power, or man-power—moving power—it will take to move given masses of these materials; and would, if called upon to put it into practice, contrive accordingly—strengthening their machinery, &c. adapting it to the work required to be done.

From this also may be shown the reason why heavy bodies appear so much lighter when moved in a fluid like water—the heavier the fluid the easier they move—as when they raise a bucketful of water from a well; its increased heaviness the moment it gets to the surface of the water—given size of the bucket how much increased in weight?—would it be heavier if raised out of the water into a vacuum, and how much?—

moving masses of stone, as granite, under water—floating beams of timber, &c. Having given the volume and the specific gravity of the fluid in which they are moving, to calculate what they lose in weight.

Suspend a cubic foot of lead by a chain from one end of a balance: what weight would balance it at the other end, or over a single pulley? A weight equal to itself.—Now let it fall into a vessel of water: will it take the same weight to balance it as before? No, sir; a weight less than itself, by the weight of a cubic foot of water.—What does a cubic foot of water weigh? 1000 ozs.—Well, I don't recollect the weight of a cubic foot of lead, but what is its specific gravity?—look at your table, 11·352; therefore the weight of the lead in air is 11352, and deducting 1000 ozs., the weight of a cubic foot of water, which is the weight lost by the lead, gives 10352, the weight necessary to balance the lead when in water.

Suppose a cubic foot of lead resting on a pile under water, what force must be exerted to pull it off, supposing no resistance from friction on the pile? About $\frac{9}{10}$ths of its own weight.

From this to explain how it is that the sand, stone, shingle, &c., are so easily tossed about on the sea-shore—how the human body floats, &c.

Questions: A vessel full of mercury, the bottom of which is nine inches by 4·56, and the height ten inches, what is its weight?

Suppose a cistern, twelve feet long, five feet wide, and four feet six inches high, made of lead a quarter of an inch thick, what would be its weight?

What is the weight of a cylinder of iron thirty inches in diameter and six feet high? Of a block of granite in the form of a circle, four feet six inches in diameter and twenty inches thick?

A statue of marble is placed in a vessel full of quicksilver, and causes six cubic feet to run over, what is its weight? Would it sink? Would a statue of cast-iron sink?

Why is the line of the angler more likely to break after the fish is out of water than when it is in it?

Do you see any connection between the weight of a given mass of matter and the altitude of the barometer? and how might a dealer in any bulky commodity profit by observing that connection?

The specific gravity of ice is to that of water as 8 to 9, and a field of ice of uniform thickness, has 10 feet above water, how many feet below it?

A cubic foot of a metal weighs 1000 lbs. when weighed in air; the weight of a cubic inch of air being about $\frac{1}{800}$th part of a cubic inch of water at a temperature of 63°, what would be the weight of the body in vacuo; also if weighed in water —and if in air of half the density,—work out the arithmetical results.

Making them reduce the fluid measures into cubic inches, feet, &c., is a good exercise.

How many cubic inches in a pint? 34·659.
in a quart?
in a gallon? &c.

Then of course they easily calculate the weight of any of these measures filled with a fluid, the specific gravity of which is given.

In aeriform bodies, common atmospheric air is taken as a standard instead of water, the weight of which is about one eight-hundredth part of the former: therefore, as a cubic foot of water weighs 1000 ozs., the weight of a foot of air will be $\frac{1000}{800}$ or 1·25 oz.; ten feet will be 12·5 ozs., 100 feet 125 ozs., &c.; then having the specific gravities of other gaseous substances, some of which are heavier, some lighter, than the atmosphere, they may be made to calculate the weights of given volumes.

The principle of the thermometer should be explained—how it is made—how graduated—and how the freezing and boiling points are determined—why the tube is of a narrow bore, &c.

In the Boys' school here there is a barometer and a thermometer, which they are in the habit of observing; registering the height when they go in, and noticing the course of its rise from increased temperature; this is registered three times a day, and a thermometer kept in the open air—the height of the barometer—the taking a weekly and a monthly average forms an exercise of their arithmetic.

Attention might be called as to how such averages of the thermometer are affected by swampy and marshy grounds of great extent—improved drainage*—how this is likely to affect

* I was told by an experienced farmer in the county of Cambridge, that he believed the average period of harvest in that county was earlier by *ten* days, within the memory of man, owing to improved drainage.

the temperature of a district, so much so, even as to advance the period of harvest—how the height of the thermometer may be affected by particular aspects—whether the line of country slopes towards the north or south, or is a level plain, &c.

The subject of heat* is one of great interest, and one on which the teacher may bring to bear a variety of experiments not attended with much expense, and having this additional recommendation, that they have an intimate relation with many of the comforts and conveniences of life.

Heat is present everywhere and in every kind of matter: we cannot measure its quantity, but we can measure the quantity in one body relatively to that of another.

The general effect of heat upon matter is to expand it, that is, an increase of heat in the same body produces an increase of volume in some proportion to the increased temperature.

This increase of volume for a given increase of temperature varies in different kinds of matter; air and gases expand most, fluids next, and then solids.

Instances of each have been mentioned—as a full kettle swelling and flowing over just before it boils—a round piece of iron fitting exactly into a ring when cold, when heated is too large.

Then, again, heated bodies impart heat to everything around them until all have acquired the same temperature; as the heater of a box-iron, for ironing linen, when put into the fire becomes red-hot like the cinder—when taken out it is put into the box, communicates heat to it, and so to the linen; and, when used for a certain time, becomes of the same temperature with the things around it.

We call things which we touch hot or cold, according as they are hotter or colder than the human body, but in this the sense of touch deceives us; when we touch a body hotter than the hand, we receive heat from it—when we touch one colder than the hand, it receives heat from us; but experience tells us that all the things in a room, when measured by a thermometer, have an equal temperature, yet they do not feel equally so to the hand.

The different degrees in which bodies conduct heat have been ascertained by experiment; air and gases, when confined, are very bad conductors: metals varying in degree among each

* The volume on Heat in Lardner's 'Cyclopædia' will be found a very useful book for the schoolmaster, and as an introduction to practical science for pupil teachers.—*Walker's Edit. of Joyce's Scientific Dialogues.*

other are good ones—generally the more dense the body, the better conductor it is.

Porous bodies are bad conductors, as are any bodies which contain air confined in cells, such as the feathers of birds—the fur of animals—the bark of trees. All these how beautiful a provision for the preservation of animal and vegetable life!

Then, again, straw, reeds, &c. are bad ones; so that a thick covering of thatch is a much better covering for a cottage, so far as warmth in winter and coolness in summer are concerned, than either tile or slate.

Tile, being rather a thick and a porous substance compared with slate, is better than the latter; and every one who is in the habit of visiting the cottages of the poor will have observed that the bedrooms of those covered with slate are in the summer extremely hot, and in winter equally cold.

Slate, again, would be better than iron.

The teacher would do well to observe the variety of fur and hair in animals, varying with the climates they inhabit; in warm climates the hairy coat of animals being short and thin, in the colder ones becoming thick and woolly. The birds of colder regions, that live in the air, have a much greater quantity of plumage than those of the warmer ones; water-fowl, such as ducks, geese, &c., have the interstices between their feathers filled up with down, more particularly on the breast. In the cold weather in winter, the birds may often be seen shaking and ruffling up their feathers in order to increase the quantity of air among them, which, being a bad conductor, helps to keep them warm.

Earth is a bad conductor, and the sharpest frosts in consequence scarcely ever get more than a few inches deep into the ground. The temperature of the earth, a very little below the surface, is the same in every climate.

In covering up a potato-pit for the winter, the lighter the soil, and the more of a covering of straw or leaves between it and the potatoes, the better they will be preserved. When it is said the frost gets to the potatoes, the thing really meant is that, the temperature of the air becoming lower than freezing point, the surface-covering of the potato-pit first gives out heat to the air, then that nearest the surface to the particles adjoining, until, last of all, the potatoes give out heat to what is resting upon them, and so the water of the potatoes gets

cooled below freezing and becomes solid, and the potato spoiled;—hence the necessity of covering them with bad conductors—not to make the soil over them a solid, but as light as possible.

On the same principle, a covering of snow is a great protection, in very severe frosts, to the more delicate plants; although the temperature may be very far below the freezing-point, and, in some climates where the cold is great, the thermometer is even down to zero, yet the temperature of the ground, under a covering of snow, would be very little below freezing. Thus water in pipes below the surface, and in springs is never frozen. In the winter, to prevent water freezing in pipes which are above ground, they are wrapped round with straw or some bad conducting substance, &c. Ice-houses with double walls—rooms with double windows are all instances of the same kind. The application of a kettle-holder, having wood or ivory handles to teapots made of metal, &c., belong to the same principle.

The following, by way of a lesson on one of the metals, *iron*, with the experiments which follow, will convey some idea to the teacher of the mode of proceeding here, and may serve as a model for the way in which he would treat the other metals:

Iron—found in the earth as a mineral—how obtained from the ore?—is a metal a solid?—can it be made fluid? Yes, sir, by great heat. Have you ever seen it fluid?—At the little foundry at the blacksmith's shop.—How does it become solid again? By cooling.—What effect has heat upon metals?* It expands them, makes them longer—it would make an iron ring larger.—Have you ever seen this property of expanding by heat turned to a useful purpose? Yes, sir; the village blacksmith hooping wheels; he makes the hoop a little too small, heats it red hot, which makes it larger, and it just fits the wheel—he then pours water upon it; it immediately contracts and makes the joints of the wheel close up and crack, and so it fits tight—

* The difference between the heat of summer and winter will cause such a variation in the length of the ordinary seconds pendulum as to affect its time of vibration; and in the building of iron bridges, allowance is obliged to be made for what is called the play of the iron, between summer and winter heat, or the whole would come down, and I believe in some of the large tubular structures of iron lately erected over rivers, allowance has been made for the unequal expansion of the metal on the sunny and shady sides.

riveting bolts,* &c.—the experiment of iron bars bringing the opposite sides of a building to an upright position from leaning outwards.

The teacher will point out the various uses to which iron can be applied—how useful from its extending under the hammer—welding (which most other metals do not), and other properties. What is welding? Heating two pieces of iron to a very great heat (called a white heat), then placing them together on the anvil, and beating them with a hammer, they unite as one piece; silver and gold will not do this. Platina welds.

Cast-iron—melted and run into a mould for shape, for grates, saucepans, boilers, teakettles, part of the plough, rollers, door-latches, gate-latches.

Did you ever in winter, in frosty weather, find out that it was colder to the hand to touch iron than wood? Yes, sir.—Why? Do not know, sir.—Teacher (making the children touch substances of different conducting powers, a piece of marble, stone, wood, wool, flax, cotton, &c., pointing out to them that all have the same temperature as the room, which is below that of the hand, and ought, so far as this is concerned, to affect it equally): Because iron is a better conductor of heat than wood or any of the others; being very cold in frosty weather, and much colder than your hand, it carries away the heat much more rapidly than wood, and it has very little to give back in return; this rapid loss of heat causes a very unpleasant sensation; if you hold the iron long enough, it will get the same degree of warmth as the hand, and the unpleasant effect will cease; the stream of heat from the iron to the hand, and the hand to the iron, will exactly balance each other; that is, the two substances, your hand the one, and the iron the other, will then impart equal heat to each other.

They may also be told to touch the different substances, marble, wood, stone, iron, &c., with their lips, which, as they are much more sensible to cold, will point out to them more strikingly how much the sense of touch deceives them.

* I am told, in testing the anchors in the Dockyard at Portsmouth, that the largest anchors have a strain on them of perhaps 150 tons, and being in length about 30 feet, and as thick as the body of a man, that immediately the strain is taken off they will collapse as much as an inch, and that this shrinking is visible to the eye of a looker-on.

Experiment. The teacher, taking a polished cylindrical piece of iron, with a piece of white paper held tightly over it, holds it in the flame of a candle, and observes it does not char—the same on a piece of wood, and exposing it in the same way, it immediately turns black; the iron being so good a conductor does not allow the heat to rest with the paper, but immediately takes it away, &c.; the wood not conducting it so rapidly causes the paper to burn.

On this principle water may be made to boil in a paper kettle, or in an egg-shell—when boiled away, both substances would immediately burn.

Experiment. Metallic rods of equal lengths and substance, one of each smeared with beeswax, and immersed in a heated fluid, the heat travels along each rod, from particle to particle,* and the one on which the wax melts first is the best conductor, the one on which it next melts the second best, and so on—the order in which the wax melts being the order in which the rods conduct the heat.

Glass—a solid, can be softened by heat, so as to be drawn out into a fine thread—allows light to pass through it; in what way does man turn this property to his use? Windows, lanterns, spectacles, telescopes, &c.; does not allow the heat of the fire to pass through it—the heat of the sun does.—What other substances allow light to pass through them? Water, horn, air, &c.

Why will a glass sometimes break by pouring hot water in it?

Answer: Solids convey heat from particle to particle, and some solids do this more slowly than others; glass conveys it very slowly, and the hot water in contact with the inner surface causes the inside surface of the glass to expand, but the outer one, not being so hot, will not follow it, and so snaps, being very brittle. Thin glass will not break so readily as thick, the distance between the two surfaces being smaller, the heat

* The following experiment, which is easily tried, shows the way in which a fluid, as water, is heated by a flame placed under it: take a glass tube, open at one end, and about an inch or so in diameter; pour water into it, so that there may be a column of several inches in length, and place it over a spirit-lamp. As the flame heats the water, drop sand into it, and a double current will be observed, one downwards along the sides of the vessel, the other upwards through the centre of the fluid; apply the heat to the surface on the sides of the vessel, and the currents will be reversed. The reason of all this to be pointed out.

gets through sooner, and the inner and outer surface are almost instantaneously raised to the same temperature—hence chemists use thin retorts.

On the subject of Metals used for the various purposes of social life, the class of teachers for whom these pages are intended may give a great deal of useful instruction.

They might draw attention to the different ores, showing specimens of them, and mentioning the kinds of earths and other substances with which they are generally mixed—where found in our own and other countries—the per centage of metal found in an ore, in one case making it what is called a rich one, in another so small as scarcely to make it worth working—anything peculiar in the way in which metallic veins run, not being stratified, &c.—depth of mines—the number of workmen employed in the mining of any particular ore, the method and necessity of transporting it from the place where it is found for the purpose of smelting, either from the people not knowing how, or for want of coal, &c.—great inconvenience of this in a commercial point of view, from having to transport so large a proportion of the ore which is useless* (there may be other substances mixed with it which are useful).

Again, the mode of separating the metal from the different ores—in some cases breaking it into small pieces and roasting it—thus driving off volatile substances, which become vapour, at a comparatively low temperature—why breaking it before this process—smelting—that when a mass of any particular ore is heated to the point at which the metal fuses, it sinks down in this fluid state to the bottom of the furnace;—to

* "When a mass of matter is to be removed, a certain force must be expended; and upon the proper economy of this force the price of transport will depend. A country must, however, have reached a high degree of civilization before it will have approached the limit of this economy. The cotton of Java is conveyed in junks to the coast of China, but from the seed not being previously separated, three quarters of the weight thus carried is not cotton. This perhaps might be justified in Java by the want of machinery to separate the seed, or by the relative cost of the operation in the two countries. But the cotton itself, as packed by the Chinese, occupies three times the bulk of an equal quantity shipped by Europeans for their own markets. Thus the freight of a given quantity of cotton costs the Chinese nearly twelve times the price to which, by a proper attention to mechanical methods, it might be reduced."—BABBAGE *on the Economy of Machinery.*

point out how certain other substances are sometimes used, called fluxes, to assist in the fusion of minerals;—that when a sufficient quantity has accumulated in a fluid state, and sunk down from the earthy and other matter in the ore, the furnace is tapped, and it runs off into moulds—called pigs, sows, &c., by the workmen.

Swansea, in Wales, a place where a good deal of ore is carried for this purpose—from Ireland, and also foreign ores are taken there.

One mode of separating silver from the other substances in the ore is by pouring in quicksilver, which unites with the silver, and is afterwards pressed out.

The metals themselves, pointing out those which are called precious metals, those which are most useful—the particular properties which make them so useful, such as being fusible, ductile, malleable, and the different degrees in which they are so; their melting-point, and the temperature at which they do melt, showing a very wide range (by calling their attention to these extremes, the instruction becomes more striking, and is more attended to)—their specific gravities, which may be pointed out from a table, making them handle the substances—platina and gold, how heavier than any of the others—twice, three times, &c., heavier than some—the property of welding only belonging to iron and platina—how much this increases the usefulness of the former.

It is easy to see the rougher and more every-day purposes of life for which the metals are used, but it will be also useful, more particularly in the schools in our large towns, to call their attention to the uses in the arts; why one metal oxidizing rapidly in the atmosphere or in water, and another not, would, in certain cases, make the latter preferable, as in the copper sheathing of ships, &c.

Again, a union of metals is called an alloy—when one is quicksilver, an amalgam;—an instance of the former, bronze, consisting of copper, with a small proportion of tin, and sometimes other metals, and used for casting statues, cannon, bells, &c.; of the latter, an amalgam of tin, with which looking-glasses are covered on the back surface; mercury very readily combines with gold, silver, lead, tin, bismuth, and zinc, but more difficultly with copper, arsenic, and antimony, and scarcely at all with platina and iron. Mercury, from the cir-

cumstance of its dissolving completely many of the less valuable metals, is very often adulterated.

Some metals have so little of affinity for each other that they have never yet been known to form an alloy, and even many whose fusing-point is nearly the same will not unite; the density of an alloy is sometimes greater than the mean density of the two metals of which it is made up, which shows that a decrease of volume has taken place, as bronze;—others again are lighter, showing an increase of bulk.

Alloys which consist of metals that fuse at different temperatures will often be decomposed by heating them to a temperature at which one of them melts; this is practised in extracting silver from copper. The copper containing silver in it is melted with three and a half times its weight of lead, and this alloy of three metals is exposed to a sufficient heat—the lead carries off the silver in its fusion, and leaves the copper in a spongy lump—the silver is afterwards got from the lead by another operation.

Alloys containing a volatile metal may be decomposed at a strong heat, driving off the metal which is volatile, as water is driven off at a less temperature from any salt it may contain.

The specific gravity of an alloy is a means of finding out the proportion of two metals in a given substance.

The substances used for soldering are instances of alloys; they are mixed metals for the purpose of uniting metallic bodies, but it will be necessary that the solder should melt at a lower temperature than the bodies to be soldered.

Those which are called hard solders will bear hammering, and are generally made of the same metal with the one to be soldered, mixed with some other which makes it more fusible.

Soft solder, such as tin and lead in equal parts, used by the glaziers, melts easily, and cannot be hammered; tin, lead, and bismuth, in equal parts, melt still more easily. In the operation of soldering, the surfaces should be made clean, otherwise they would not unite so well. The glaziers use resin with the solder, to prevent the metals rusting, uniting with the oxygen of the air.

A bar (whose length at 32° is taken at unity) of the following substances will, when heated to 212°, the boiling-point of water at the ordinary pressure of the atmosphere, expand: glass, $\frac{1}{1116}$ of its length; steel, about $\frac{1}{807}$; iron, $\frac{1}{846}$; copper,

$\frac{1}{58}$; silver, $\frac{1}{524}$; tin, $\frac{1}{462}$; lead, $\frac{1}{351}$; or a rod of iron whose length (temperature 32°) is 846 inches, will, at the heat of boiling water, expand one inch, and become 847; tin, length 462 inches, would become 463.*

In consequence of this expansion of iron by heat, it is necessary to make allowance for it in building bridges, otherwise the difference between winter and summer heat might cause an expansion which would bring down the bridge.

Again, on the absorption and radiation of heat by different substances a few useful lessons may be given, and the simple and well-known experiments of Leslie, which are easily tried, may be made very instructive.

From these it is shown that smooth polished surfaces of metal reflect heat, and absorb comparatively little; that scratching or in any way roughening the surface of a metallic body increases its power of absorption, and blackening it with anything increases it still more.†

Experiment. Take, for instance, three circular pieces of metal, as tin, nine inches in diameter, and raised on a stand of a few inches high—one smooth, another scratched and roughened, the third blackened—the back of each being smeared with tallow, or some substance which melts at a low temperature; then placing a red-hot ball of iron at equal distances from any two of them, it will be found that the tallow on the blackened one will very soon melt, that on the roughened surface next, while the smooth surface would remain nearly at the temperature of the room; of course this experiment might be tried with different substances, and metals scratched and blackened in different degrees.

Another of Leslie's experiments. Take a cubical vessel, made of tin, one surface blackened, a second scratched, the third more roughened, and the last smooth; fill it with boiling water, and place his differential thermometer near it, and turning each side in succession towards it, it will be found that the quantity of heat radiated, or thrown off from the different surfaces, will be in the order mentioned above. Professor Leslie covered the surface of the vessel with thin plates or layers of different substances of different colours, and noted

* See Appendix (B). † List of Apparatus, in Appendix.

the number of degrees which the thermometer rose, and thus ascertained the radiating power of each particular covering.

Lamp-black*	100°	Clean lead	19°
Writing-paper	98	Iron, polished	15
Tarnished lead	45	Tinplate	12

He then, instead of blackening or otherwise meddling with the faces of the tin vessel, made it perfectly smooth, and covered the bulb of the thermometer with the different substances, and found by the way in which it was affected that they absorbed heat much in the same way as they had before radiated it when on the tin vessel.

His experiment of heat reflected from parabolic reflectors is a very curious one, and they are well worth the expense of purchasing, in order to try the experiment, from the instruction it gives. A pair of these reflectors is a useful apparatus in a school.

As an instance of roughened bodies absorbing heat and then radiating it again, and of polished surfaces reflecting it—take the case of a blackened rough fender and polished fire-irons—the latter are generally nearer the fire than the fender, touch them and they will be found much the coolest; the fender having absorbed the heat, the irons reflected it.

The different degrees in which bodies absorb heat depends also on colour.

Dr. Franklin observed that when he laid pieces of differently coloured cloth upon snow, it melted more rapidly under the dark colours than the light. And black and red inks, for example, when exposed to the sun, become heated in different degrees from their absorbing the light which falls upon them, and consequently the heat in different degrees; while pure water seems to transmit all the rays equally, and is not sensibly heated by the passing light of the sun.

The teacher should also note the difference between the radiation of heat from the sun and that from any other bodies—that from the sun passing through air and glass, water, &c., the other not, or if so, in a very slight degree.

The following experiment, attended with no expense, affords

* Although heat is emitted from every point in the surface of a hot body in all directions, it is not emitted in all directions with the same intensity. The intensity of the heating ray is as the sine of the angle which it makes with the surface, and therefore those rays have the greatest heating power which are emitted at an angle of 90°.

a good practical hint—two old tea-pots will serve, one of white metal, the other of black earthenware.

Fill them with boiling water, or with hot water from the same kettle—after standing a given time, place a thermometer in them, and it will be found that it will stand much higher in the metal one than in the other; showing that for the purposes of making tea the metal one is the better, not radiating the heat so rapidly; but if placed before the fire the black one will absorb heat better than the other. A black earthen teapot loses heat by radiation, in the proportion of 100; while one of silver or other polished metal loses only as 12.

Thus hot water running in a blackened pipe or rough one, will give out its heat more rapidly than in a polished smooth one.

A solid, when changed into a fluid state, absorbs heat—some solids soften in melting, as wax, tallow, butter, and then become fluid; others, as ice, change at once.

In changing from a fluid to a state of vapour, heat also is absorbed; on the contrary, bodies in passing from vapour to fluid, and from fluid to solid, give out heat.

Water in freezing gives out heat, while in the melting of snow and ice heat is absorbed; hence the chilling cold felt in a thaw, after there has been a great fall of snow; also the gradual melting, in consequence of the latent heat in changing from snow into water.

Fluids become vapour also at different temperatures, their boiling-point depending upon the pressure of the atmosphere, which varies with the altitude above the level of the sea, as well as from other causes; they may also be heated beyond their boiling-point in the atmosphere, by subjecting them to artificial pressure.

The following questions will suggest a few important things, on which the teacher who wishes to understand this subject may inform himself.

Why, as water in boiling becomes vapour, and as it were boils away, does its temperature not rise above 212°? When all converted into steam at 212°, what would take place if immediately condensed? What has become of all the heat required to convert the water into vapour, and how would it show itself when the steam is condensed?

If the steam were heated above 212°, how is its expansive

force increased? Simply as the temperature, or in a higher ratio?*

Why, when a mass of ice is dissolved from the heat of a room, or in a vessel on the fire, does the temperature of the water not rise, so long as any ice remains undissolved—(test this by placing a thermometer in melting ice), and why does it rise as soon as it is all melted?

Water being kept perfectly still, may be cooled many degrees below the freezing-point, but if shaken, ice would immediately be formed. The extent to which it freezes at once when shaken depends upon this, whether the quantity of heat given out on freezing is sufficient to raise the temperature of the rest higher than 32°. If, for instance, the mass is cooled to 10° below the freezing-point, then only $\frac{1}{14}$th is immediately frozen, and in becoming solid it has given out sufficient heat to raise the temperature of the rest up to the point of freezing.

The circumstance of water, when cooled below 39° of Fahrenheit, expanding when further reduced in temperature, should be noticed—this is shown from ice being lighter than water—from the bursting of water-pipes when frozen.

How beautiful the design of Providence in this arrangement, that when the surface water is near the freezing-point, being lighter than that which is underneath, it cannot sink. If it had followed the general law, rivers would begin to freeze from the bottom, and become a solid mass of ice—fish and all the other inhabitants of the water would be destroyed: ice also a bad conductor.

Why can the human body bear to be brought in contact with air at a much higher temperature than with a fluid—with a fluid than with a solid, such as hot iron?

A fluid boils, when its temperature is raised to such a point that the elasticity of its vapour is sufficient to overcome the pressure which is acting upon it: whether from the cohesiveness of the substance itself, the pressure of the atmosphere, or any other artificial pressure.

This explains the principle of a vessel called Papin's Digester, made to extract all the nutritive matter from bones. It is a cylindrical vessel, capable of resisting great pressure;

* The disruption of vegetable substances produced by the passage of the electric fluid through a tree is caused by the intensity of the momentary heat converting the fluid of the wood into steam.

closed by a stopcock, which will resist a pressure of many atmospheres. Of course, in this, water may be heated far above the ordinary boiling-point, and from its greater heat, most animal substances are made to dissolve.

The boiling-point is not changed by bodies mechanically mixed in a fluid—as sand in water; but it is by all those chemically united with it. All soluble salts retard the boiling-point of water, and substances such as starch, mechanically mixed with it, retard its cooling.*

The processes in the arts and manufactures carried on by distillation and evaporation should be noticed. The continual evaporation going on at all temperatures from every part of the surface of the globe—land and water, animal and vegetable—increasing the transparency of the atmosphere, sometimes when most charged with vapour it is most transparent—at others forming clouds, descending in rain to supply our rivers and springs, and to sustain the whole animal and vegetable world.

Formation of vapour absorbs heat, and therefore produces cold—instance a wet towel applied to the temples in case of headache—sometimes wrapped round a bottle containing any thing which requires to be cooled—damping the mats in a doorway—a damp bed a very dangerous thing, for want of exercise to generate heat in the body, so as to counteract the cold in drying, &c. That evaporation produced cold had been known in warm climates from an early period, but this had escaped notice in the more temperate ones, until after the invention of the thermometer, when it was soon perceived that on the bulb being wetted, the mercury immediately fell in the stem.

The following may be taken as a way of applying this knowledge to the teaching of children:

Sugar from the sugar cane. The juices are pressed out by passing the cane between heavy rollers; this contains, besides sugar, a great deal of water—the water is driven off by boiling—will go away slowly by evaporation.

A current of air over anything that is wet takes the moisture up in vapour, as it passes over the surface; this changing the wet upon anything into vapour is called evaporation, and

* The reader will see some interesting tables on the freezing and boiling points of liquids, &c., on the melting-points of solids, such as fat, metals, &c., at the end of the volume on Heat in Lardner's 'Cyclopædia;' as also on their expansions at different temperatures. See Appendix (B).

produces cold; dip your finger in water, when there is so little wind that you do not know from what quarter it comes, and you will find the finger colder on one side than the other, this is the side on which the wind blows, and it is colder because there is a greater evaporation on that side of the finger than on the other. The sailor knows this, and when he is becalmed at sea, and does not know from what quarter the wind blows, he wets his finger in his mouth, and holds it up to the air, the cold side is the wind side.

After a shower of rain on your clothes, and whilst they are drying on your back, do you not feel much colder than you did before?—this is the cold arising from the wet on your clothes becoming vapour—and for this reason you should not sit in your wet clothes after you get home.

Why does your ink get thick by standing in the inkstand? This, after what you have heard, you can answer yourselves.

In cold weather you will sometimes observe a quantity of water collected at the bottom of the panes of glass in a room—you recollect warm air holds up more vapour than cold—the warm air in the room coming in contact with the glass, which is cold from being in contact with the cold air of the atmosphere, is immediately made cooler; this causes the vapour in it to condense on the surface of the glass—become water—it then runs down, and collects in large drops on the wood.*

With the aid of a sectional model of the steam-engine, and knowing something of the elastic power of vapour—that its force of elasticity increases in a much higher ratio than that of its temperature—that when reduced below a certain temperature it is immediately condensed—the teacher would be able to explain many of the more important parts of the machine, showing how steam may be adapted to the purposes of man as a moving power.

He would explain how the steam enters alternately below and above the piston rod, and is carried off—by its elasticity giving an up and down motion to the large beam which sets the machinery in motion—pointing out the parallel motion at the end of the beam, causing the piston rod always to move in the same vertical plane—the up and down motion of the

* What becomes of it? Point out how it is perhaps first absorbed by the wood—is changed again into vapour—again mixes with the atmosphere—reappears in rain—fertilizes the fields, &c.

beam causing two dead points, one at its highest, the other at the lowest point of its motion—how the contrivance of a fly-wheel, by its momentum when once set in motion, carries the machinery over the dead points, &c.

Then again—the importance of having a great quantity of fire surface in the boiler, in order to generate steam rapidly—the saving of fuel by this—the different kinds of boilers in order to effect it—the nature of safety-valves—that a safety-valve is, in fact, a weak part of the boiler made to give way when the elastic force of the vapour, from increased temperature, becomes so great as to endanger its bursting—the valve opens (or ought to do), at a pressure much below that which would burst the material of which the boiler is made—gauges for measuring the pressure on every square inch of surface at which the engine is working—nature of an atmospheric safety-valve opening inwards, and why wanted, &c.; that if the steam inside the boiler is suddenly condensed, the boiler would have a tendency to collapse, and an atmospheric valve would guard against this.

Again, when the water in the boiler is very low, the fire-surface of the boiler above the water would become heated in a very high degree; danger from this, in an engine not stationary, as in a steam-boat, of the water, from the rolling motion of the boat, being thrown over the heated surface, and all converted into steam, and an explosion taking place—not perhaps immediately, but after the heated surface was cooled down to a certain temperature.

The boiler of the locomotive steam-engine is of a tubular kind, in order to expose as much surface as possible to the fire; and in this engine, as there can be no fly-wheel to get over the dead points, there are in each machine two engines at work, the dead points of which are at right angles to each other, so that they never occur together.

The following from Herschel's 'Discourse on the Study of Natural Philosophy,' will give the reader some idea of these hidden powers of nature when called into action, and show him how much they are perhaps beyond anything he may have been in the habit of imagining them.

"It is well known to modern engineers that there is virtue in a bushel of coals, properly consumed, to raise seventy millions of pounds weight a foot high. This is actually the

average effect of an engine at this moment working in Cornwall. Let us pause a moment and consider what this is equivalent to in matters of practice.

"The ascent of Mont Blanc from the valley of Chamouni is considered, and with justice, as the most toilsome feat that a strong man can execute in two days. The combustion of two pounds of coals would place him on the summit.

"The Menai Bridge consists of a mass of iron, not less than four millions of pounds in weight, suspended at a medium height of about 120 feet above the sea. The consumption of seven bushels of coals would suffice to raise it to the place where it hangs."

It will, perhaps, be difficult to understand the following description of what may be called the mechanical effects of a jet of steam without having recourse to diagrams; but they are curious, and as the same thing may in some measure be tried by a current of air blown or sent rapidly through a hollow tube, this may suggest simple things of an interesting kind.

A jet of steam issuing outwards in any direction, but suppose vertically from an orifice, will ascend into the air, with greater or less force, according to its temperature and elasticity, and will by its momentum displace the air which it meets with in its upward course. The jet will be rendered visible by the steam being condensed, and the effect of this jet upon the flame of any burning substance—or any light substances brought near to the axis of it—by its attracting them (a current of air setting in on all sides towards the axis of the jet), is striking and worthy of attention.

Take a piece of tow, dipped in spirits of wine and placed at the end of a rod, set it on fire, and approach the flame near the axis of the steam jet; when held a little above the orifice from which the steam proceeds, the flame will be attracted in a slanting direction, and the angle which the flame makes with the axis of the jet increases as the distance from the orifice increases, up to a certain point, when it becomes a right angle; elevated above this it again assumes the position it had below this point, until it is elevated beyond the influence of the jet, when it of course assumes a vertical position.

This is better shown by taking a circular piece of iron, with a handle attached, and wrapped round with tow: moisten it with spirits of wine and kindle it, then place the circle of

flame across the axis of the jet—up to a certain point above the orifice the flame will assume a conical appearance, here it will set itself at right angles to the jet, and appear a flat disc of flame—above this point the flame will again become a conical surface, until being farther elevated, it gets beyond the influence of the jet, and assumes an undisturbed position.

Light bodies when placed in the jet, or heavy bodies within certain limits, when placed in it, will be supported, or a flat surface of any kind held in the hand at a certain distance from the orifice will be forced upwards; but brought close to it, or in contact with the surface in which is the orifice of the jet, it will be held down with considerable force.

It is from these properties of a jet of steam, that it has been proposed to ventilate coal and other mines, by creating a strong current of air up one shaft, to be supplied by a down current from another, which could be regulated at pleasure, and in such a way as to produce even a gentle breeze or a perfect hurricane in the mine.

The same principle may be shown by taking a hollow tube of glass, or of tin, having two arms at right angles to each other for the convenience of blowing through, otherwise, a straight tube would do as well, and one end terminating in a perforated pasteboard, or tin disc, of a few inches diameter, through the centre of which the tubular opening runs, then blowing violently through it, and placing another piece of pasteboard, or tin, over the opening from which the air proceeds, it will be found to adhere, and to be violently attracted—if the apparatus be turned downwards, so that the current instead of ascending is blown towards the ground, the under surface will be lifted up.

If water is poured into a bent glass tube, open at both ends, and a current of air is blown violently across one end, the water in it will be found to rise.

On the subject of light there are many simple things easy of explanation, connected with experiments of so simple a kind, that the teacher may with advantage turn them to account in his teaching.

That some bodies, such as the sun—the stars—flame of all kinds—bodies heated to a red heat, are self-luminous, possessing in themselves the power of throwing off light; others again, not being themselves the source of light, reflect that

which they receive from self-luminous bodies. The flame of a candle is seen by the light which proceeds directly from it; the things in the room are seen by the light thrown upon them from the candle, and reflected back to the eye.

Light is sent off from luminous bodies in every direction, and proceeds in straight lines.*

Instance. A ray of light admitted or finding its way through a small hole into a dark room—if there is dust or smoke in the room its progress will be distinctly observed proceeding in a straight line—if it is received on a dark surface, at the opposite side of the room in which it enters, most of the light is absorbed, and the room scarcely lighted at all by it—if on a white surface, such as a sheet of paper, much more light is reflected on the objects around.

Also beams of light from the sun, passing through the opening in a cloud, darting in straight lines to the ground—the outline of a shadow, being always that of the object seen from the luminous point, shows the same.

Hold a flat object between the candle and the wall, the image is of the exact form of the outline of the object—the image of a globe—of a flat circle of the same diameter, held parallel to the wall, and to the flame of the candle—of a cylinder, with its end towards the centre of light, is the same, and these different bodies would not be distinguished from each other by their shadows.

The shadow of a flat circle, when held slantingly, would differ, &c. How? what would it be when the circle is held with its plane perpendicular to the surface on which the

* Why does the light passing through a window light the whole room, and not appear a mere column of light, the base of which is equal to the size and figure of the window, and why any light on each side of this column? Or, rather why is it not a set of separate columns, as many in number as the panes of glass, and having circular, or square bases, &c., according as the panes may be circles, squares, diamonds, &c. with dark spaces of the thickness of the bars of the window between each column of light; so that a person walking from one side of the room to another would pass through alternate sections of light and darkness—the same, also, vertically, from the bottom to the top, caused by the cross bars: each column of light, supposing the floor to be horizontal, and the window at right angles to it, would be inclined to the plane of the room, at an angle equal to the angle of incidence on the glass.

In bringing candles into a room during twilight, whether would there be more or less light in the room by closing the window-shutters?

shadow is cast? The darkness of a shadow will not be in proportion to the real darkness, but in proportion to the quantity of light on the surrounding objects; try the shadow of a hand on the wall, as made by one candle, and then place another so that the shadows from the two candles coincide; it will be seen that this appears much darker than the former one, and why? Vary the position of the candles so that part of one shadow rests on the other—the comparative darkness will be very visible.

When the body from which light comes is less than that which causes the shadow, the shadow will be greater than the body—the shadow of a hand on the wall (luminous body, flame of a candle), of a small paper figure of a man, may be made of any size greater than itself, by varying the distance of the candle and object from the wall.

When the body from which light comes is greater than the body causing the shadow, the latter will always be less than the object;—this is the case with the shadows of all the planets and of the earth, because less than the sun—the nearer to the body causing the shadow, the greater the shadowed surface.

When light falls upon any body whatever, part of it is reflected, part of it absorbed, and either lost in it, or proceeds through it; when on a brightly polished surface, most of it is reflected, and the remainder lost,—when on glass or water, very little is reflected, and the greater part transmitted through it.*

A given quantity of light or heat, such as that from a candle or from the sun, will be less intense the greater the space it is spread over—the intensity of both diminishes as the square of the distance increases; a person standing near a fire (the heat given out remaining constant), if he remove to twice the distance, will only receive $\frac{1}{4}$ of the warmth, at three times only $\frac{1}{9}$, at four times $\frac{1}{16}$; the same of light.

* "The quantity of light which is reflected by a substance of any kind, depends not only on the nature of the substance, but also on the obliquity of its incidence; and it sometimes happens that a surface which reflects a smaller portion of direct light than another, reflects a greater portion when the light falls very obliquely on its surface. It has been found that the surface of water reflected only one fifty-fifth part of the light falling perpendicularly upon it—that of glass one fortieth, and that of quicksilver more than two thirds: but when the obliquity was as great as possible, the water reflected nearly three fourths of the incident light, and the glass about two thirds only."—YOUNG'S *Lectures*.

Light* falling on polished metals, or any polished surface, is reflected at an angle made between the reflected ray, and a perpendicular to the reflecting surface, which is equal to the angle which the incident ray makes with the same perpendicular.

When a ray of light falls perpendicularly, it is sent back in the same line.

The image of an object, placed before a plane mirror, appears to be at an equal distance from the glass with the object, but on the opposite side of it. Place a boy or hold an object in such a position that the rays fall obliquely on the mirror; a person, in order to see it, must stand in a direction making the same angle with the other side.

Place two looking-glasses parallel to each other, and a lighted candle between them, and observe an infinite number of images, each in succession dimmer than the one before it, and why. Explain also the distances from each other and from the glass.

Light passes through some substances, as glass, water, ice, rock-crystal, &c., but, on entering, is bent at the surface; and in going out, if it passes through, is again bent at the other surface.

A ray of light entering from air into water is bent downwards—in passing from water into air, it is bent from the perpendicular to the surface of the water; so that a body in the water, as a fish, or the bottom of the river appears elevated, and the fish higher, or the water less deep than it really is—people not knowing this, mistake the depth of water; if looking perpendicularly downwards the object appears in its true place.

Exp. Put a shilling into an empty basin, place it on a table, and recede until the eye entirely loses sight of the shilling, or in fact of any particular point in the bottom of the basin, keep the head in that position, and let some one pour water into the basin, and the shilling will gradually appear—parts of the bottom surface of the basin will come in sight which before were not visible. If spirits of wine were used for this experiment, the shilling will appear more raised, and if oil still more; but in none of these cases will it be thrown aside to the right or to the left of its true place, however the eye be situated.

* A glass mirror reflects the light without the heat absorbing the latter; while a metallic mirror reflects both light and heat, so that it is not quickly warmed, unless its surface is blackened.

The ray having once entered one of these transparent substances, passes on in a straight line, and, when coming out on the other side, its direction is parallel to that in which it first entered. The different refractive powers of transparent liquids vary, but so constant is it in the same substance, that the purity of oils can be tested as a matter of commerce by their refractive powers, and that this mode of examination is had recourse to, in order to test whether an oil has been adulterated or not.

A ray of light from the sun, when it enters the atmosphere, which increases in density the nearer the earth, moves in a curve which is concave towards the earth, this causes the sun to appear to us in the horizon before he is actually above it.

Light proceeding from the sun, as well as heat, the more of the atmosphere they have to pass through before they reach us, the less intense they will be—much of both being lost in the passage. The stratum of air, also, in the horizon is so much more dense than that in the vertical, that the sun's light is diminished 1300 times in passing through it, which enables us to look at him when setting without being dazzled. The loss of light and of heat by the absorbing power of the atmosphere increases with the obliquity of incidence. There is no known substance which is perfectly pervious to light: all transparent substances absorb in different degrees the light falling upon them. The clearest crystal, the purest air or water, stop some of the rays of light on its passage through them, and of course the thicker the medium the greater the quantity of light absorbed; on this account objects cannot be seen at the bottom of very deep water, and there are more stars visible to the naked eye from the tops of mountains than from the valleys: the quantity of light incident on any transparent substance is always greater than the sum of the reflected and refracted rays. Bodies which reflect all the rays appear white, those which absorb them all seem black; but most substances after decomposing the light which falls upon them reflect some colours and absorb the rest, and appear of that colour the rays of which they reflect, for they all receive their colour from their power of stopping or absorbing some of the colours of white light and transmitting others.

From the quantity of watery vapour in the atmosphere

varying, objects at the same distance at one time appear more distinct and larger than at another.

The experiment of letting light from the sun fall on a triangular prism of glass, will interest—seeing the separation into the different prismatic colours—let them observe the order in which they follow—the image being white, excepting when the rays proceed from the prism at a particular angle; cover first one side of it with paper and then another, which shows to them on which side it enters and which it goes out at—otherwise they will not understand. This separation of colours by refraction is perhaps the most striking thing which can be brought before them belonging to this class of experiments.

Tell them when they see a rainbow to observe the order of the colours—the order in the secondary bow. Calling their attention to things of this kind even in this simple way is of great service.

Many of them have seen a heated coal, or the red-hot end of a stick whirled rapidly round, or moved quickly in a straight line;—show them that the fiery end cannot be in every point of the circle or of the line at the same time; and that it must be moved with such rapidity, that the impression of it on the eye while at any particular point must rest until it comes there again; the stick in one case appearing a circle, in the other a line of fire.

The impression of light lasts on the retina about one sixth of a second, therefore it must whirl round six times in a second, or come from any one point in the line to the same again in one sixth of a second, as the least velocity which would produce this effect.

Of the same kind a meteor, called a falling star, which is a luminous point in rapid motion—the motion of a rocket, &c.

The following is a very instructive experiment: Take a circular disc of white pasteboard, or perhaps better, paste white paper on a circular piece of board, and having divided the surface into sections of proper proportions, and painted on them the prismatic colours—when made to revolve rapidly it will appear white—if whirled round in a dark room, and with the same rapidity which before produced white, when lighted by an electric spark, all the colours are as distinctly visible as if the wheel were at rest; in this case the wheel has moved

through no visible angle, while the light lasted, and may be taken to have been at rest; if lighted by a flash from gunpowder, they will be less distinct, but here the duration of light is longer.*

Transparent substances, as glass, may be made into such forms that the light falling on them, after passing through, may be brought to a point at particular distances.

The eye is of this nature, and it collects the light which falls upon it from objects around, and brings them to a point on what is called the retina—when they are exactly brought to a point there the sight is good;—when the surface of the eye is too round, the image is not in its proper place, and as people get older, in the generality of cases, the eye becomes too flat;—to assist them in both cases, lenses (when used in this way called spectacles) are had recourse to, and by the assistance of these, the image is formed at the proper point;—when the eye is too flat, the image is behind the retina, when too round, between the retina and the eye; but in neither case can people see well.

Short-sighted people have the eye too convex, long-sighted too flat; this latter defect comes with age, or increases as people get older, which is the reason why they cannot read without spectacles.

This does not increase the quantity of light, as light is lost in passing through the spectacles.

The effort which every one whose sight is beginning to fail feels himself making in order to read, or see anything which

* "It has generally been supposed, since the time of Newton, that when the rays of light are separated as completely as possible by means of refraction, they exhibit seven varieties of colour, related to each other with respect to the extent that they occupy in ratios nearly analogous to those of the ascending scale of the minor mode in music. The observations were, however, imperfect, and the analogy wholly imaginary. Dr. Wollaston has determined the division of the coloured image or spectrum in a much more accurate manner than had been done before; by looking through a prism, at a narrow line of light, he produces a more effectual separation of the colours than can be obtained by the common method of throwing the sun's image on a wall. The spectrum proved in this manner consists of four colours only, red, green, blue, and violet, which occupy spaces in the proportion of 16, 23, 36, and 25, respectively, making together 100 for the whole length; the red being nearly one sixth, the green and violet each about one fourth, and the blue more than one third of the length."—YOUNG's *Lectures.*

is indistinct, is to bring the lens of the eye into such a form, that the image may be formed in its proper place.

Then a teacher would ask them if they had never observed the effect of going out from a lighted room on a dark night, how little they could see at first, and the sort of muscular action going on in the eye, so as to adjust it to collect more light;—the contrary, going from dark to great light, as in opening the shutters of a bedroom window on a bright morning, causing a sort of involuntary effort of the eye to contract, and exclude part of the light—reflection of light from snow causing pain, &c.

Owls, &c., and animals which see well at night having the power of dilating the pupil of the eye, so as to take in more light.

To have a perfect sight, the lens of the eye must be so shaped that the image is formed exactly on the retina.*

ASTRONOMY.

There are a few facts connected with Astronomy, and, when properly explained, not very difficult to comprehend, which ought to form a part of the instruction given in our schools.

The apparent motion of the heavenly bodies—that this is caused in part by a real motion of the spectator, which he himself is not aware of—that the movements we see of the sun, and among the stars, are not all real ones, but owing to our point of view changing every moment.

* Sir John Herschel, in his Discourse on the Study of Natural Philosophy, mentions, among others not less striking, the following instance of theory and pure mathematical analysis leading to results such as no ordinary practical reasoning would be able to get at, being contrary, as it were, to one's every-day experience.

"An eminent living geometer had proved by calculations founded on strict optical principles, that in the *centre of the shadow* of a small circular plate of metal, exposed in a dark room to a beam of light emanating from a *very small brilliant point*, there ought to be no darkness—in fact, *no shadow*, at that place; but on the contrary, a degree of illumination precisely as bright as if the metal plate were away. Strange and even impossible as this conclusion may seem, it has been put to the trial and found perfectly correct.

"Cases like this," he justly adds, "are the triumph of theories."—HERSCHEL'S *Discourse on Nat. Phil.*

That all these bodies appearing to be in a blue concave sphere, in which we see them on a fine night, and at nearly equal distances from us, are not really so—that some are millions and millions of miles farther from us than others—some are fixed, and do not change their position with respect to each other, and called fixed stars—others, again, are moving in circular orbits round the sun, in the same manner as the earth does, of which a certain number are known—their distances from the sun—the time of revolving in their orbits accurately calculated; that is, the time from one of these bodies leaving any one point in its orbit until it comes to the same point again—these are called planets—some of them, again, having satellites or moons revolving round them, in the same way as the moon round our earth.

Again, that some of them are self-luminous bodies, like the sun, as the fixed stars—others, like our moon, are not in themselves luminous, but appear to be so by reflecting the light thrown upon them by the sun—this explains the various phases of the moon, new moon, full moon—otherwise, if she were a luminous body, she would always appear the same, &c.

These and similar things which they may be taught are no doubt quite opposed to their preconceived notions, so far as they may have notions at all, or have ever thought on the subject; but I can say, from my own experience, that when explained in a simple way they excite a very lively interest, and are not only highly instructive as to the facts themselves, but may be made a means of imparting to the youthful mind strong feelings of a religious character.

"I saw the glorious sun arise
In morning's early gray,
I saw him light the eastern skies,
And melt the shades away.

Who made the sun to shine so bright,
The heavens to adorn?
Who turn'd the darkness into light,
And gave us back the morn?

'Twas God who made the sun so bright,
The heavens to adorn;
'Twas God who made the darkness light,
And gave us back the morn."

Sung in the school by the children.

Having become acquainted with the different lines on the surface of a terrestrial globe,* they should be made to understand the two motions of the earth, one in its orbit causing the variation of the seasons, the other of rotation, causing day and night, and that this motion on its axis from west to east causes an apparent motion of the sun and stars from east to west.

Turning the globe from west to east (having first elevated the pole to the latitude of the place), it is easily understood that a point on the surface near the pole describes a very small circle, and that every point which is more distant describes a larger one, till we reach the equator, any point on which describes a great circle, and that from the equator to the south pole these circles go on decreasing.

Hence the teacher would call attention to the tendency which a body would have to fly off from the surface of the earth, caused by this rotation—that the more rapid the motion, the greater this tendency—that the motion being greatest at the equator and decreasing towards the poles, this tendency to fly off, would be greater there than at any other point; and would in all cases diminish the weight of bodies, and that this was found by experience to be the case; a body at the equator loses from this $\frac{1}{289}$ of its weight.

This tendency to fly off is always at right angles to a perpendicular to the axis of rotation, and at the equator is at right angles to the direction of gravity.†

Why is a bird in its flight not left behind by this rotation of the earth on its axis? or, why does not the lark soaring in the sky find the field moved from under her when she descends?

He might then instance the dirt or wet flying from a cart- or carriage-wheel in rapid motion over dirty roads—the water

* "This earth of ours is a huge mass, self-poised, supported upon nothing, hung upon nothing—enveloped by the air which we breathe, and surrounded by the space of the heavens.

"How many thoughts does the mind embrace in this idea!"

MOSELEY's *Astro-Theology*.

† The centrifugal force at any point on the earth's surface acts at right angles to a perpendicular let fall from that point on the axis of rotation, and varies in magnitude as that perpendicular which is the cosine of the latitude; at the equator this force is at right angles to the direction of gravity, and is a maximum, the latitude being 0, and the cosine equal to radius; at the pole it is nothing, the latitude being 90°, and cosine of 90° is 0.

from a wet mop when twirled round—from a grindstone when the blacksmith is grinding tools;—then to show how easy it is, from knowing the properties of a circle, to calculate the absolute space moved through by any point on the surface of the earth in twenty-four hours, or in any given time; that any point must revolve from west to east, and will in a complete revolution describe the parallel of latitude in which it is;—giving them the length of a degree of longitude in that latitude, they would work out the arithmetic of it, and for one, two, three, &c. hours, as the case may be; ask—what points on the earth's surface describe the greatest space, and what the least, in twenty-four hours?

The difference between the polar and equatorial diameter. Again, pointing out that every section of a sphere must be a circle, and that knowing the circumference they can find the diameter—or the line which would reach from any one point to the one differing in longitude 180° from it—also the area of the section or slice of the earth which the plane of a parallel of latitude makes.

The following questions may interest a teacher who has a tolerable knowledge of the subject, and suggest others.

(1) The length of a degree of longitude in our latitude is 37·76 geographical miles: compare the velocity of a point on the earth's surface here arising from the motion of rotation, with the velocity of a point on the equator.

(2) If the earth's diameter were only one half what it is, what proportion would the mass, the surface, and the different land divisions of this new globe bear to those of the present one, and what would be the size of each in square miles?

The teacher should work this question out numerically to its final results; it only requires a knowledge of the properties of a circle and of a globe, that the circumferences of circles vary as their diameters, the areas as the squares; and that the solid contents of spheres are as the cubes of their diameters.

Archimedes* more than two thousand years ago discovered that the superficies of a sphere is equal to the convex surface of the circumscribing cylinder, or to the area of four of its great circles; and that the solidity of the sphere is to that of

* See Appendix B, Table I.

its circumscribing cylinder as 2 to 3. He was so pleased with this discovery, that he ordered a sphere inscribed in a cylinder to be placed on his tomb, and the numbers which express the ratio of these solids.

As a means of giving correct ideas of the apparent motions of the heavenly bodies, a celestial globe will be necessary. This, to an unpractised eye, seems a mass of confusion, but by confining the attention at first to a few particular stars, particularly those near the pole, and by degrees extending it to others, it will be found very simple.

It is essential to make them understand how the elevation of the pole, or the apparent place of the pole-star, varies—that at the equator the poles are in the horizon, and at the poles directly over head.

Having elevated the pole according to the latitude, and otherwise regulated it for any particular day and hour in the year, they may conceive the equinoctial and ecliptic as the corresponding lines of the terrestrial globe swollen out to the blue vault of the sky—the teacher would point out, for instance, the constellation of the Great Bear, and how to find the pole-star from it; others, as Capella in Auriga, &c., which never get below the horizon—that the stars near the pole-star appear to move in circles round it from east to west—that this is in consequence of their own motion with the surface of the globe from west to east—that the farther a star is from the pole-star, the greater the circle it describes, until you get to those which rise due east—that such a star would describe a greater circle than one rising either to the north or south of east, and that stars rising further to the south will appear to describe smaller and smaller arcs in the heavens, until you get to those which only just make their appearance on the horizon—such as a star of the first magnitude (Fomalhaut) in Piscis Australis—those further south not rising to us at all, but describing circles round the south pole, in the same way as the stars in the Great Bear and others do round the north.

Then by degrees to call the attention to others, such as a star (Vega) of the first magnitude in Lyra—Arcturus, Regulus, Antares in the Scorpion, &c., marking those in and near the ecliptic—point out also the direction of the Milky Way, and the particular stars near it on each side, east or west of it.

Then turning the globe from west to east, show the rising, &c., or particular parts of the heavens where the more remarkable stars are to be found, at hours when they may themselves observe them—where they will be at eight, nine o'clock, &c., near the horizon in the east—or that they must turn their faces to the south, the west, &c., to see them; as also their apparent distance from the pole-star; and they will have the greatest pleasure in hunting them out and watching their motions.

When a right conception of the apparent motion of a few of the more important stars is formed, that of the rest scattered among them becomes an easy matter of reasoning which is soon filled up, always bearing in mind their apparent distances from the pole-star—watching those which never set in their highest and lowest points, beginning with them in the east; conceive how the observers must turn in order to see them in the different parts of the circle they appear to describe, until they come to the same point again.

That if they can observe one of those stars to change its position with respect to any star which they know to be fixed—if they find its angular distance from a fixed point increase or decrease—that this is called a planet—that the planets move in orbits inclined to the plane of the ecliptic, but that their path is never far from that of the sun—some nearer the sun—some farther from it than the earth—the difference this must cause in the quantity of heat and light falling upon them—that in one it would melt iron and lead—that they would not be known as solids, water only as an elastic vapour—while in another, perhaps, quicksilver, water, &c., would be solid substances, capable of being quarried out in blocks like Aberdeen granite—gases would become solid, &c.

Then to point out their respective distances from the sun—their periods of revolution in their orbits—their satellites, &c.—the exactness with which astronomers are able to make all these calculations—changes of the moon and her different phases.

That if the plane of the orbit in which the moon moves were extended, it does not lie in the plane of the ecliptic, but inclined to it, at an angle of about 5°; that at new moon, the sun, moon, and earth are in a straight line, and that side of the moon which receives light from the sun is turned entirely from us, so that none of her reflected light can reach the

earth—that by her motion in her orbit she separates herself, moving to the east, about 13° daily from the sun—that a day or two after the change we see a small crescent of light, concave towards the east; this goes on increasing daily with her angular distance from the sun, until she appears in the part of the heavens directly opposite to him, when it is full moon—the whole enlightened surface of the moon being turned towards the earth. She now goes on decreasing, rising later on successive evenings, the waning side being convex towards the west.

Call attention also to the points of the horizon on which she rises—when due south—the arc described in the heavens—her varying distance from particular stars—and why the difference in time between successive risings of what is called the Harvest Moon, is less than at any other time of the year. That the orbit in which the earth moves is not a circle, but an oval or ellipse with the sun in one of the foci—show how an ellipse may be described—that the sun is nearer the earth in winter than in summer—how the point of the horizon on which he rises varies, being farthest to the south in winter, and to the north of east in summer—how his altitude when on the meridian varies, being much greater in summer than in winter; the effect of this, so far as heat is concerned—that the length of time between sunrise and sunset varies, as you leave the equator, all the way up to the pole—the duration of twilight short at the equator, longer at other places as the latitude increases, and why? The sun not getting so high in the heavens in winter as in summer, the rays fall in a more slanting direction on the earth's surface, and on this account at this season, as well as from his not being so long above the horizon, less warmth is communicated to the earth than in summer. On fields with an aspect to the north, the rays will fall still more slantingly than on those turned to the south or on a horizontal plain, and in such situations less warmth will be given to the soil or to any substances upon it; hence vegetation in the spring is not so forward in a northern as in a southern aspect—the hoar frost in autumn remains up till noon, or even the whole day, in aspects turned to the north, but vanishes early in those to the south—the same of snow remaining on the north side of hills—other reasons also, such as cold winds from the north. What must be the inclination

towards the north, on any given day, that the rays may fall parallel to the surface? What the inclination to the north beyond which the surface would be entirely in the shade? What the aspect to the south, that the rays of the sun may fall perpendicularly to the surface on any given day?

Light travels from the sun to the earth in $7\frac{1}{2}$ minutes, at the rate of 192,500 miles in a second of time.

It moves through a space equal to the circumference of the earth in $\frac{1}{8}$th part of a second—a space which would take the swiftest bird three weeks to fly over.

Again, point out the difference between sidereal and solar time—day—year: how a solar day is not always of the same length—clocks regulated by mean solar time, &c.: how the period of time we call a year does not consist of an exact number of days, as 365; and hence the difficulty in regulating the calendar.*

That the sidereal day, or the time between any meridian leaving a particular star, and coming to it again, is always the same, the star not having moved in the interval—that this is not the case with the sun—that in the interval between any two successive passages of the same meridian under him, he has moved on towards the east, and this daily motion being unequal, causes the length of a solar day to vary. A clock tells mean time, and is therefore sometimes before, and sometimes behind solar time.

That the time of the earth's making a complete revolution in its orbit is 365 days 5 hours and 48 minutes; so that if

* "Hipparchus, the most celebrated astronomer of antiquity, and who lived about a century and a half before Christ, first paid great attention to the rising and setting of the stars; he discovered that the period of 365 days 6 hours, which had been considered as the true length of the solar year, was too great by about five minutes, and observed that the four parts, into which the year is divided by the solstices and equinoxes, are by no means equal, the sun occupying $94\frac{1}{2}$ days in passing from the vernal equinox to the summer solstice, and only $92\frac{1}{2}$ from the same solstice to the autumnal equinox, and that therefore the sun remained 187 days in that part of the ecliptic which lies north of the equator, and only 178 in the other part."—*Encycl. Brit.*

Laplace concludes that the mean heat of the earth cannot be altered by 1° of Reaumur since the time of Hipparchus, inasmuch as the dimensions of the globe would be thereby changed in a small amount, its angular velocity increased or diminished, and a sensible difference be made in the length of the day—and this is found not to be the case.

leap-year is made to occur every four years, this would be too often, and require correction.

On the subject of Eclipses. There is no phenomena connected with the appearances and motions of the heavenly bodies which creates so much astonishment among those who have never thought on the subject, as an eclipse of the sun and moon; and that the time of their having happened, or of their happening for the future, can be so exactly computed, is a subject of no less wonder.

It is familiar to every one, that an opaque body of sufficient size may be so placed between a luminous body and the eye of an observer, as to stop all the light proceeding from it, and in this case the luminous body becomes invisible.

Now an eclipse happens in consequence of one of the opaque bodies, the earth and the moon, being so placed as to prevent the light falling upon the other.

The moon coming between the sun and earth causes an eclipse of the sun, and this happens at new moon, when she is between the earth and sun, and hinders the rays of light from falling upon the earth.

The earth coming between the sun and moon causes an eclipse of the moon, and happens at the same instant of absolute time to all observers—longitude calculated from this.

The shadow of the earth or moon is conical, having the area of a great circle for its base. The length of the earth's shadow is 216·511 semi-diameters of the earth.

What is meant by the transit of a planet over the sun's disc? How is it that the transit of Mercury, on the 9th of November, 1848, could not be seen to its termination by an observer in Paris, but would by one in Ireland?

Facts of this kind, when understood, many of which they will be able afterwards to verify by their own observation, will to many, I have no doubt, be a source of rational enjoyment in their homes, and make them feel that they belong to a class of beings of an intellectual kind; instead of being unmoved or stupefied by the grandeur of the appearances about them, they will turn their thoughts to that God who made them, and call to mind the lessons they have learned at school in their childhood.

Child of the earth! oh! lift your glance
To yon bright firmament's expanse!
The glories of its realm explore,
And gaze, and wonder, and adore!

Doth it not speak to every sense
The marvels of Omnipotence?
Seest thou not there the Almighty name,
Inscribed in characters of flame?

Count o'er those lamps of quenchless light,
That sparkle through the shades of night;
Behold them!—can a mortal boast
To number that celestial host?

Mark well each little star, whose rays
In distant splendour meet thy gaze;
Each is a world, by Him sustain'd,
Who from eternity hath reign'd.

Each, kindled not for earth alone,
Hath circling planets of its own,
And beings, whose existence springs
From Him, the all-powerful King of kings.

Haply, those glorious beings know
No stain of guilt, nor tear of woe;
But raising still the adoring voice,
For ever in their God rejoice.

What then art *thou*, oh! child of clay!
Amid creation's grandeur, say?
E'en as an insect on the breeze,
E'en as a dew-drop, lost in seas!

Yet fear not thou—the sovereign hand,
Which spreads the ocean and the land,
And hung the rolling spheres in air,
Hath, e'en for thee, a Father's care.

Be thou at peace! the all-seeing eye,
Pervading earth, and air, and sky,
The searching glance which none may flee,
Is still, in mercy, turn'd on thee.

Mrs. Hemans.

CHEMISTRY.

The subject of Chemistry is one which may be made both interesting and useful, perhaps more so than almost any other of a secular kind, in the class of schools for which these pages are written, whether in towns or in the rural districts.

About two years ago, the subject of chemical agriculture

was introduced in this school, with Professor Johnston's Catechism as a text-book, and sufficient apparatus for the experiments required to illustrate it. What has been done, and the way in which it has been received, is a sufficient proof that instruction in this might form an important feature at the larger class of schools in our rural districts, where the teachers are qualified to give it, or where those interested in the school have an inclination to introduce it; this would attract the attention of the farmer as regards his own children, not that I think that is wanted; when the education in our parish schools is in other respects good, they will, in the end, avail themselves of it. The difficulty is in finding qualified teachers, but let them once be properly remunerated, and society made to feel and estimate at its proper value the real worth of a sound practical education, preparing them for the duties of this life as well as for a future existence, this difficulty will cease, and qualified teachers will soon be found: nor is it too much to expect from the most advanced nation in the world, as to its political and social constitution, science, and wealth, that it should grant a liberal allowance to the education of its youth: were it to do so, the gain, even in a pecuniary point of view, would in the end be great, independent of those moral considerations which ought never to be lost sight of.

The first object of the farmer is to produce food for man and beast in the cheapest way he can—to get the most productive crops, at the least possible expense; and although experience is not to be despised, yet, assisted by science, much more may be done than without it—this it is difficult to persuade the farmers; some knowledge of manures, they think, may be of service, but beyond the 'Muck Manual,' in the way of book-learning, very few of them are inclined to go—still they are on the march, and when they see their way, through experiments successfully tried, prejudices will give way; there is something of wisdom in not abandoning a tolerably good plan, unless you have confidence in the one which is recommended being better, and the road to confidence is practical proof.

One of the first questions naturally would be—of what are all these plants composed?—On inquiry, they are all found to consist of two classes of substances, varying with different plants, one of which is volatile, called organic, the other, which

remains after combustion, in the form of ashes, and called inorganic—these again are analysed into their separate elements, and it is thus seen what the plant is made up of.

Now, it is evident that if the seed, after it is sown and germinates, as well as grasses, during their growth, cannot find such substances as they are composed of, the crop must necessarily be an unproductive one, and that in proportion to the deficiency of the substances required. The next question is—

Where are they to find all the things which enter into their composition?—which of them can be supplied by the industry of the farmer?—and which of them must he trust to atmospheric influences to supply?

To this science gives an answer—the farmer judges from experience—the agricultural chemist would analyse the soil, and find out its separate elements—he knows the elements of the crop he wants to grow, and knowing which of these are to be found in the soil, and for which he must trust to the atmosphere, he would use that kind of manure which would supply the rest—and that such substances as any particular crop is known to take away, must be supplied in the shape of manure, otherwise the land will be worn out.

A knowledge of the particular substances which a crop of any kind, as wheat, barley, &c., takes out of the ground, and of what is wanted by the crop which is intended to follow, would point out a good rotation of cropping; and, in addition to this, knowing the composition of the soil, would lead to a proper economy in not casting useless substances upon the land as manure—such substances as did not contain the particular things wanted.

This does not apply merely to grain-crops, but to all others; and although long experience may have taught the farmer a right course as to the ordinary crops, yet, take the case of a new plant, a grass, or other plant which is recommended, he is then at a loss as to the soil he ought to try it in; he therefore goes by guess—if he hits upon a favorable soil he pronounces in its favour, if not it is condemned, and it will only be after a long time, and after many successful or unsuccessful trials and much expense, that it is found out what soil will suit this plant and what will not. Now, here science might help to a speedier and less expensive mode of trying it—by burning the plant, examining the ashes, and analysing the soil in which

it is intended to be tried, this would show whether they suit each other or not.

Thus science, with caution, may at once point out a right course, when it would take years of experience to find it out.

Then, again, with respect to manures, although a substance thrown on the ground may contain the ingredient wanted, it may not contain it in such a form that the plant can avail itself of it. Here, again, science steps in, and teaches that the nourishment which plants take up by the roots must necessarily be in a fluid form—that they cannot assimilate to themselves any substance in a solid state, although it may be the very thing they like best, and that therefore it will be necessary to use such manures as are soluble in water—by the rains which fall, or which, from exposure to the atmosphere, become so—that after decomposition every animal and vegetable substance returns in one shape or other—the organic parts through the atmosphere in a gaseous form—the inorganic as solid substances thrown upon the ground, for the future nourishment of plants, and through them, of animals.

Also, with respect to the food of animals, chemistry points out what particular food is best fitted for a required purpose; the proximate principles of fleshy matter, such as form the muscles, fat, are formed in the plants, the stomach of animals dissolve the compound substances into their proximate principles, they circulate through the blood, and are thus assimilated to the different parts of the body.

For instance, the farmer wishes the calf, the lamb, or colt, to become a well-grown animal, to have muscle, bone, and sinew; the cow to give milk which will yield a great deal of butter and cheese, excepting in large towns, where they want quantity and not quality; the ox he wants to feed on such substances as will leave the most of fat on his bones.

In all these cases, from knowing the composition of the different vegetable substances, such as turnips, swedes, mangel-wurzel, different kinds of hay, &c., there is something of a guide as to what plants would be best suited for any particular purpose.

The farmer knows that one grass field is better than another for young stock, for milk, for fattening, &c., which is nothing more than that the grasses in one field are of that kind which has more in them of those substances of which bone, muscle, &c., is made—in another more of the substance of milk—and

in the third of fatty matter; here experience has taught that which science would confirm, if the agricultural chemist were to analyse the grasses which most abound in such pastures.

Calling attention, also, to the influence of light—heat—moisture, &c. in the atmosphere—wet and cold seasons, &c. on vegetation—that a great deal of rain has a tendency on many soils to produce more straw in our cereal crops than dry weather, &c.; in fact, calling the thinking faculties of man more into action in the business of agriculture, and not making it in the same degree that mechanical routine sort of thing which, of all other occupations carried on in this country, it has hitherto been, and thought to require less of intellect than anything else. Of all occupations it is that which is most natural to man, and that without which we cannot exist.

When a knowledge has been obtained of the simple elements of which vegetable matter is composed, and of the substances, starch, gluten, oil or fat, and inorganic matter, which a healthy animal ought to derive from its food, it will be found useful and instructive to call attention to the ascertained quantities of each of these in given weights of particular kinds of grain—or other substances of a nutritive kind, such as the following:—

According to Johnston, in his 'Chemical Catechism,' "100 lbs. of wheaten flour contain about 50 lbs. of starch, 10 lbs. of gluten, and 2 or 3 lbs. of oil.

"In 100 lbs. of oats there are about 60 lbs. of starch, 16 lbs. of gluten, and 6 lbs. of oil.

"In 100 lbs. of potatoes, about 75 lbs. of water, and from 15 to 20 lbs. of starch; and in 100 lbs. of turnips there are about 88 lbs. of water.

"And of animal substances, 100 lbs. of butter contain from 10 to 12 lbs. of water, about 1 lb. of curd; the rest is fat.

"100 lbs. of cheese contain from 30 to 45 lbs. of water; skim-milk cheese from 6 to 10 lbs. per cent. of butter; full-milk cheese from 20 to 30 lbs. per cent. of butter, and about as much pure curd."

Tables, also, similar to the following, connected with the chemistry of food and of nutrition, and which is taken from Brandt, may be made a means of suggesting most useful observations. This shows the change which takes place in the proximate elements of barley, in the process of malting:

	Composition of Barley.	Composition of Malt.
Starch	598	431
Gluten	57	12
Albumen	4	0
Diastasse	0	2
Sugar	46	154
Gum	44	150
Oil	4	4
Salts	5	5
Husk	136	136
Water	106	106
	1000	1000

The most remarkable change being of a large quantity of starch into the substances sugar and gum.

An exact knowledge of the nutritive properties of vegetable substances—food for man and beast—and the exact proportions, both quantitative and qualitative, in each, is of great importance to an agricultural people, as having a tendency to induce them to cultivate the most nutritive kind; and one can scarcely conceive a people having such knowledge, and bringing their mind to bear upon it—cultivating, for instance, the potato—as food for man—considering also its perishable nature, to the extent which the Irish have done, in preference to crops of a cereal kind.

That great permanent benefit will be conferred upon the farming classes by the introduction of such instruction into our schools there can be no doubt, not only in an increase of produce arising out of improved modes of culture as regards the soil, but, in addition to this, it will lead to an improved culture of the mind in the rising generation of agricultural youth, and make them, as a body, a much more intelligent class of men than they are at present.

The village schoolmaster who attempts anything of this kind should, in addition to a general knowledge of the particular substances which constitute the ordinary crops, be able to manipulate in a few of the common routine things in general chemistry—in making the ordinary gases, hydrogen, oxygen, carbonic-acid gas, &c.—to show that this last is not a simple but a compound substance, and constitutes nearly one half of all the chalk, limestone, marble, &c. on the earth;* let them

* The quantity of carbonic-acid gas locked up in every cubic yard of

feel the weight of a piece of chalk or limestone before and after being burnt into lime—the different specific gravities of these gases—that one is combustible—another is a supporter of it, and to such a degree that iron will burn in it—that carbonic-acid gas extinguishes flame, destroying animal life when breathed into the lungs—danger of sleeping in a close room where charcoal is burning, or near a lime-kiln, &c.* To show that all these, although the same to the eye, may in other ways be tested and made out. That ammonia consists of two gases, nitrogen and hydrogen, and how formed in the decomposition of plants and animals.

To make out by experiment that air is not a simple body, by burning a taper under a bell-jar over water, &c., or a piece of phosphorus, but is made up of oxygen and nitrogen, about $\frac{1}{5}$th in bulk being oxygen and $\frac{4}{5}$ths nitrogen, also the different compounds which this forms with oxygen, &c.

That water is not a simple substance, but is composed of two elements, oxygen and hydrogen, in the proportion of 1 to 2 in volume and 8 to 1 in weight, and when analysed, that the two simple elements can be again reunited to form water.

The hot iron which the blacksmith plunges into his water-trough decomposes the water—the oxygen of the water uniting with the iron and forming an oxide of iron, which is sometimes seen as a flaky substance on the surface, the hydrogen being set free, mixed with some impurity which gives it an offensive smell: the same when the kettle boils over or water is thrown into the fire.

That salt is made up of a vapour called chlorine and a metal called sodium—that sulphur, mercury, and the metals, as far as is yet known, are simple substances, and to point out the more common ones—to explain and make them understand what is meant by a salt made up of a base and an acid, &c.—the way in which acids and alkalies act upon vegetable colours—how they neutralize each other—tests for them, &c.

limestone has been estimated at 16,000 cubic feet. The quantity locked up in coal, in which its basis carbon forms from 64 to 75 per cent., must also be enormous; if all this were set free, extinction of animal life, &c.; to suggest any mode of approximating to the weight of carbonic-acid gas locked up in a given weight of chalk—a cubic foot for instance—by weighing it before being converted into lime and weighing it afterwards—difference in weight arising from the gases driven off.

* Five per cent. of this gas in the atmosphere would be highly deleterious, and ten per cent. would be entirely destructive to animal life.

In order to form definite notions of the relative weight and substances of such bodies as the gases, of matters the existence of which is not evident to the sight, it will be necessary to have recourse to the balance: this, in the case of common air, may easily be done by exhausting the ordinary brass bottle, the volume of which is a quart, by means of the air-pump; in the case of the following the weights would be found—

	Weight of quart.	Weight of cubic foot.
Atmospheric air . .	$21\frac{2}{3}$ gr. . .	$1\frac{1}{5}$ oz.
Hydrogen . . .	$1\frac{1}{2}$ . . .	$\frac{1}{12}$
Oxygen . . .	$23\frac{4}{5}$ . . .	$1\frac{1}{3}$
Nitrogen . . .	$21\frac{4}{5}$ . . .	$1\frac{1}{6}$
Carbonic acid . . .	$32\frac{2}{3}$ . . .	$1\frac{9}{10}$

The simple fact of showing how these invisible substances can be handled—those which are heavier than common air, poured from one vessel to another, like water—can be pumped out, and even, by a dexterous manipulator, ladled out by the hands, proving that the transfer is really made by testing in the ordinary way, is of itself most instructive.

The teacher might easily show this in the case of carbonic-acid gas, by taking a quantity of bruised chalk or limestone, powdered marble, or bruised oyster shells—place them in the bottom of an open vessel (a rather tall glass one would be best), then pour sulphuric acid diluted with water upon them, when this gas would be copiously given off—would rest at the lower part of the vessel, rising as the quantity increased—then letting a lighted taper be gradually lowered, the point to which the gas had risen would soon be seen by the taper becoming dim, and when sunk a little further it would entirely go out.

To know that the gas given off from the substances above is actually carbonic acid, it would not be sufficient merely to know that it is heavier than common air; but it must also be shown that it will not support combustion—will make lime water turbid—and is an acid, by turning vegetable blues red.

It is also instructive to collect this gas by displacement—making it in a vessel into which a bent tube will fit, giving it a direction into any vessel into which the gas can descend, and thus displace the air of the atmosphere. It will be found very instructive to perform this experiment in the following way: balance a glass jar at one end of a scale-beam, and then

allow the carbonic acid to displace the air of the atmosphere: the end of the beam on which the jar is suspended will very soon begin to descend, thus showing the pouring in a heavier air than the one which previously occupied it—a thing not evident to the sight, but made so in this way: restore the equilibrium by means of pieces of paper—test the height to which the carbonic-acid gas has risen, by dipping in a lighted taper.

Also, show that it is a compound substance formed by the chemical union of carbon, a solid, with oxygen—that one atom of carbon unites with two of oxygen, the chemical equivalents of which are 6 and 16, forming a compound substance, of which 22 is the equivalent—the resulting gas not being an increase in volume over the oxygen with which the carbon united, but an increase of specific gravity, by the interpenetration of the substances.

For instance, if the exact quantity of carbon were burnt in a jar containing the exact quantity of oxygen with which the carbon would unite, the result would be carbonic acid, equal in volume to the volume of oxygen, but of course specifically heavier, and having all the properties of the former, the solid carbon thus united having become invisible.

This carbon may be thrown down again, and would show itself in a volume of smoke—the black and restored carbon.

The following experiment, which is easily made, would show the change which atmospheric air undergoes by being passed through the lungs.

Take a jar with an air-tight stopper, and such as is used for pneumatic purposes—if open at the lower end it must be placed over water—take out the stopper and place the mouth over the opening—inhale* and exhale the air several times by breathing with the mouth over the opening, and taking care that no air from the atmosphere gets in; put in the stopper, and then test the air—it will be found to have all the properties of carbonic acid—will put out a light, make lime water turbid, &c.

The same may be done by breathing through a bent tube into an inverted jar; the upper end of which is closed; this,

* It is found that lungs of an ordinary capacity will take in about 160 cubic inches of air, and the greatest about 295. A man of five feet one inch takes in about 160, and eight additional cubic inches for every inch in height is found to be a very near approximation to what really takes place in life.

after having passed through the lungs and breathed out, will ascend, being heated and mixed with watery vapour, and on raising a lighted taper towards the top of the vessel, or depressing the vessel upon the taper, it will be extinguished.

The reason why this gas breathed out by animals ascends, the gas itself at the temperature of the atmosphere being heavier than common air, is, that it comes from the animal heated, and is mixed with watery vapour.

As a curious result of the chemical inquiries of the present age, it has been ascertained that the quantity of carbonic acid breathed out by a healthy man in 24 hours is about $13\frac{3}{4}$ oz., of which about 7 oz. is solid carbon;* about 63 oz. by a cow, and about 70 oz. by a horse; and that an approximate calculation founded on this would give about 500 tons, breathed out by the population of London; and that the quantity of carbon breathed out by the whole animal race would be sufficient to supply all the vegetable world on the surface of the globe.

The mode of making common coal gas—the process which is going on in the burning of the gas, or of a candle—how the water which is formed during the combustion—the carbonic acid, &c.—is returned through the atmosphere again to assume the form of vegetable life, &c.—that a given weight of wood, for instance, or of any other combustible body, when consumed, if all the parts were collected, would weigh more even than the wood, and why?—that when they burn wood on their own fires, elm will leave more ashes than beech—beech than oak—oak than willow, &c., and that consequently these trees during their growth carry away different quantities of inorganic matter from the soil—that leaves make more ash than straw—straw than grain.

These are things not difficult to understand—but they ought to be taught by experiment, and all that is required may, by a person at all well acquainted with the subject, be done at very little expense. There are numberless ways of showing

* It has been ascertained by a Swedish philosopher experimenting on a healthy man about thirty-five years of age, confined in a small chamber into which air entered by a hole on one side, and examining it after it passed though at the other, that the carbon ejected per hour was 105 grs. fasting; 190 grs. after breakfast; 130 when hungry; 165 two hours after dinner; 160 after tea: and 100 sleeping; making about 7 oz. daily.

the principle of many of these things, not only in the arts, &c., which would apply more particularly to towns, but in the common every-day things of life, whether in town or country, and calling attention to them when an experiment is performed, is of more service in an educational point of view than those without experience are at all aware of.

Many examples might be brought forward where even the remarks of ordinary workmen have led to discourses of a most important kind; but the two following, from Sir John Herschel's 'Discourse on Natural Philosophy,' are particularly striking: "A soap manufacturer remarks that the residuum of his ley, when exhausted of the alkali for which he employs it, produces a corrosion of his copper boiler, for which he cannot account. He puts it into the hands of a chemist for analysis, and the result is, the discovery of one of the most singular and important chemical elements, iodine. Curiosity is excited: the origin of the new substance is traced to the sea-plants, from whose ashes the principal ingredient of soap is obtained, and ultimately to the sea-water itself. It is thence hunted through nature, discovered in salt mines, springs, &c., and pursued into all bodies which have a marine origin: among the rest, sponge. A medical practitioner then calls to mind a reputed remedy for the cure of one of the most grievous and unsightly disorders to which the human species is subject—the goître—which infests the inhabitants of mountainous districts, and which is said to have been originally cured by the ashes of burnt sponge. Led by this indication, he tries the effect of iodine on that complaint, and the result establishes the extraordinary fact that this singular substance, taken as a medicine, acts with the utmost promptitude and energy on goître (of course, like all medicines, with occasional failures), as a specific against that odious deformity."

Another instance affording a safeguard of human life, and a remedy for a more serious evil: "In needle manufactories, the workmen who point needles are constantly exposed to excessively minute particles of steel which fly from the grindstones, as the finest dust in the air, and are inhaled with their breath; this in time produces a constitutional irritation dependent on the tonic properties of the steel, which is sure to end in pulmonary consumption: insomuch, that persons em-

ployed in this kind of work, used scarcely ever to attain the age of forty years. In vain was it attempted to purify the air, before its entry into the lungs, by gauzes or linen guards; the dust was too fine and penetrating to be obstructed by such coarse expedients, until some ingenious person bethought himself of the motions and arrangements of a few steel-filings on a sheet of paper held over a magnet. Masks of magnetized steel are now constructed, and adapted to the faces of the workmen. By these the air is not merely strained, but searched in its passage through them, and each obnoxious atom arrested in its progress."

Also Davy's safety-lamp, lightning conductors, &c., are all instances of the application of sciences to the most valuable purposes of social life.

Of the great usefulness of being acquainted through experiment with facts in science which are of a practical kind, a knowledge of which, from experience, I am convinced is attainable in our best elementary schools, the following striking instance occurred while these pages were going through the press. The philosophy of it is very interesting, and on this account, as well as from its being an important practical lesson, I give it here: it shows also, that the very means we take to protect both life and property may, through ignorance, increase the danger we wish to avoid, and is an instance, where a knowledge of science prevented what might otherwise have been attended with most serious results. Being in London, I went with a friend to the Royal Institution, to hear a lecture which had been announced on the manufacture of glass, and on the application of various metallic substances in colouring it, &c.; on arriving there, we found there was no lecture, some danger of fire having arisen from the furnaces erected for the occasion. On the subsequent Friday, Professor Faraday gave a very interesting account of this accident. The heat of the furnaces and fire resting on the bricks of the fire-place in the lecture-room, had so heated the bricks, as to char the ends of some joists on which the floor rested, and the ends of which ran up nearly to the fire-place, and were in contact with the bricks; this caused a smell of fire, water was thrown on the fire in the fire-place to extinguish it, and while this was being done, a workman went into the room below, and broke the ceiling at a distance from the fire-place,

and spying every now and then a flame issuing out, thought nothing could stop it. This being pointed out to Professor Faraday, he immediately saw that the water thrown for the purpose of putting out the fire, falling on the heated bricks, was decomposed, and the hydrogen, by the pressure of the steam above, was forced downwards, and coming in contact with the charred beams, took fire, the beam ends being sufficiently hot to ignite it, so that the very means taken to extinguish it was adding to the danger. He then directed the water to be thrown on the heated substances near the fire, and these being cooled down below the point which would cause the gas to ignite, there was of course no further danger in throwing water on the fire.

The facts of a scientific kind connected with this are by no means difficult to understand, and are such as an experienced workman, who had seen experiments on the composition and decomposition of water—how the compound substance could be separated into two others, by coming in contact with a heated surface, like the bricks, and that one of them, hydrogen, was very inflammable, and would ignite at a low temperature—that the oxygen would assist the combustion—would easily understand: the lesson taught him would be that, in a case of this kind, instead of continuing to throw water on the fire and on the bricks, he would immediately direct it to be poured on the heated materials around, and then pour water again on the fire; when, even if gas were evolved, there would be nothing near it of a sufficiently high temperature to ignite it.

Facts in science such as these have a direct practical bearing, and when it is seen how much of property in towns, nay, of life itself, may depend upon a knowledge of them among what are called our more experienced workmen, their importance will be understood.

GEOLOGY.

There are many interesting facts in Geology, particularly such as apply to the locality in which a school is situated, or which have reference to agriculture, to which attention might be called.

Boys may be easily made to understand what is meant by

stratified and unstratified rocks; that the order of superposition of the different strata is found to be the same in every country, and in every part of the globe; and there are a few leading features which might be mentioned, without going into detail as to the fossils that distinguish one set of beds or one formation from another—such as where a stratum is found to abound in fossils of a marine character—animals that must have lived in the sea—that these denote a submarine formation;—that one abounding with those of a fresh-water character denotes a fresh-water formation;—and, having formed an idea of the order in which the different strata rest one upon another, to notice the strata which prevail in their own neighbourhood—for instance in this part of Hampshire—the chalk—that this is divided into two, the upper and the lower—the one containing flints, the other without flints* the soil resting on the upper not so good for arable purposes as for pasturage—that on the lower chalk partaking of the character of a good soil, and being of a marly nature, is better for the purposes of agriculture.

That the unstratified rocks form hills, mountain chains, &c., often one mass of the same material, as granite—that the stratified rocks rest upon the other, but that the hills of granite have been upheaved through these primary rocks, as is shown, by laying bare the strata, where they rest on the mountain sides.

That the mineral ingredients of a soil partake very much of the character of the rocks in the neighbourhood, and of those on which they are superposed; if, in digging through the surface-bed of soil, we come at chalk as the prevailing substratum, the soil itself, when analysed, would be found to contain a great deal of this substance—if a limestone, it would be of a calcareous nature, &c.

Of the nature of this degradation and crumbling away, it would be easy to refer to instances in almost any neighbourhood—such as chalk cliffs, limestone rocks, deep pits, &c.—how the atmosphere is the chief agent in this—by the action

* These nodules of flint when broken, will many of them appear inside of a spongy or porous texture, and the chalk being a submarine formation, they are supposed to have been formed by a deposit of the siliceous matter in sea-water around the sponge, the substance of which gradually going away has been replaced by this flinty deposit.

of heat and cold—of frost and thaw, &c. Thus the depth, &c., of soil will depend much on the rock being easily decomposed, or of a soft nature.

Then, again, the practical purposes to which a knowledge of this superposition of the different strata may be turned. If they come in the order 1, 2, 3, 4, &c., and you live upon No. 2, it is of no use attempting to find No. 1 below it, or No. 2 below No. 3—to point out the use of this knowledge in boring for water—in looking for beds of coal—and in all mining purposes—the needless and immense expenditure of money which a want of this knowledge has sometimes led to.

That alluvial deposits at the mouths of rivers, in cases where the sea has receded, will be found containing a soil which has been transported from great distances, as the annual overflowings of the Nile, the Ganges, &c. These gradually deposit an accumulation of soil over large extents of country; and although this soil may differ from the character of the rocks in the neighbourhood, yet the fact, when inquired into, admits of easy explanation by the geologist.

From what has been said on the absorption and radiation of heat in some of the preceding pages, it will easily be seen that the degree of warmth which a soil will acquire from the sun's heat will depend very much upon its nature, and this will again very materially affect the vegetation. Professor Johnston says, that when the temperature of the air in the shade is no higher than 60° or 70°, a dry soil may become so warm as to raise the thermometer to 90° or 100°. The temperature in wet soils rises more slowly, and never attains the same height as in dry by 10° or 15°. Hence, wet soils are called cold, evaporation causing it. This to be corrected by draining. "Dry sands and clays, and blackish garden mould become warmed to nearly an equal degree under the same sun; brownish-red soils are heated somewhat more, and dark-coloured heat the most of all."

The farmer, hitherto, never seems to have thought much about the analysis of soils, but it is one deserving of great attention, and can only be done by those who are well skilled in this department of chemistry, and can pay great attention to it.

A geological map of England, on a tolerably large scale,

pointing out the extent of country over which any particular formation extends—whether chalk, red sandstone, &c.; also the coal fields—districts where the iron and other ores are found—slate, tin, lead, copper—and this coloured for the purpose, with references at the side, is a most useful piece of school apparatus;—it not only gives a teacher an opportunity of pointing out where those minerals are to be found—how they effect the agriculture of a district—the character of its population and their employments—attracting an agricultural or a manufacturing class—but the children get a great deal of information by examining the map themselves. I have very often found a boy answering questions on this subject, of which I had no notion that he had any idea, and have found that he had got at the knowledge himself, from the inspection of a geological map on the walls of the room.

There are many things of an ordinary STATISTICAL kind, connected with our social economy, our manufactures, &c., which might be made subjects of useful lessons to the boys in a school; such as the population of the different parts of the United Kingdom at periods when a census has been taken—the decennial increase, the average annual increase, and this whether greater in the manufacturing or agricultural districts—the average number to a house, in 1831, in Great Britain 5·62, in 1841, 5·44, so that, at the latter period, there would seem to have been an increase of houses in a greater ratio than the increase of population.

The average consumption of each person in some of the common articles of life would also be interesting, as affording ideas of a definite kind as to the average consumption of a family in a village, a town, a county, &c.

This was for the United Kingdom:

	lbs.	
Of sugar in 1840 . . .	15·28	for each person.
,, 1841 . . .	17·65	,, ,,
	lb. oz.	
Of coffee in 1831 . . .	1 5·4	,, ,,
,, 1841 . . .	1 7·55	,, ,,
Of tea in 1831 . . .	1 3·93	,, ,,
,, 1841 . . .	1 5·96	,, ,,

Soap, in 1831, 6·23lbs. each, and in 1841, 9·2lbs. each, showing that the nation is progressing in the use of soap in

a greater ratio than in an increase of population, and that, if there is not an increased consumption of it in the arts, we are progressing in cleanliness.

Then, again, the consumption of coal as fuel, and the extent of our coal fields, how this enables us to turn large tracts of land to arable purposes, which, in this climate, must otherwise have grown wood;—coal, for smelting purposes—for making gas to light our towns—this mode of lighting introduced at no great distant period, and better for the purpose than oil.

In England the coal field is about $\frac{1}{20}$th of the whole surface, in Belgium $\frac{1}{30}$th, in France $\frac{1}{200}$th.

Different kinds of coal differ in their heating powers.

Table showing the relative heating powers of certain combustible materials.

Best turf	1
Beech-wood	0·862
Danish coal	1·275 to 1·524
Swedish coal	1·611
Faroe coal	1·672
English Newcastle	2·256
Scotch	2·387

Economy of a Coal Field.—JOHNSTON.

The great improvement of late years in the habits of the upper and middle classes in this country, more particularly as to drunkenness—but not a corresponding improvement in the lower and working classes in this respect—this much to be regretted.

On manufacturing subjects. The number employed in each particular class of manufacture—the potteries—cotton, silk manufactures, &c.—cutlery, and working in metals, &c.—where all these are carried on—the increased value given to the raw material when worked up—this partly in proportion to the time and skill required.

There is on this subject some very instructive information, in a tabular form, in Babbage on the 'Economy of Machinery,' but the calculations are made for the year 1825, and therefore would not exactly apply at present.

The following are a few of them:

Lead, of the value of £1, when manufactured into—	
Sheets or Pipes, of moderate dimensions	£1·25
Ordinary printing characters	4·90
The smallest type	28·30
Copper, worth £1, became, when manufactured into copper-sheeting	1·26

Household utensils	£4·77
Woven into metallic cloth, each square inch of which contains 10,000 meshes	52·23
Bar iron, worth £1, when manufactured into—	
Agricultural implements, became	3·57
Barrels, musket ,,	9·10
Blades, razor, cast steel ,,	53·57
Blades, of table-knives ,,	35·70
Door-latches and bolts, from	4·85 to 8·50
Files, common, became	2·55
Horseshoes ,,	2·55
Saws, for wood ,,	14·28
Needles, of various sizes, from	17·33 to 70·85
&c. &c.	

The above are given simply for the purpose of suggesting inquiry as to the value of labour compared with that of the material in manufactured products;—other instances of a domestic kind would occur—such as the value of the raw material wool, of different qualities, compared with the price of a pair of stockings—a yard of flannel—of a coat of the kind ordinarily worn—of a hat, &c.

The increased value given to the skins of animals, when manufactured into shoes, gloves, harness, saddlery, or any other thing made of leather, &c.

Increase of value in flax when manufactured into linen, tablecloths, made into sheets, &c.,—pointing out the advantages to a country in being able to manufacture its raw products, whether of a mineral or a vegetable kind, over one which is obliged to export them in a raw state for the purpose of being worked up:—also to what causes it is owing that particular manufactures are located in particular districts—as that of cotton in Lancashire—woollen at Leeds—cutlery at Sheffield, &c.

Too much attention cannot be given to all these things of an industrial character, from which they can form a definite idea of the comparative money value which society pays for the various branches of industry, of skilled and unskilled labour, &c.

Of the extent to which internal communication and rapid modes of conveyance may increase the power and affect the productive industry of a country, the following passage taken from Babbage may give the reader some idea:

"On the Manchester railroad, for example, above half a

million of persons travel annually; and supposing each person to save only one hour in the time of transit between Manchester and Liverpool, a saving of five hundred thousand hours, or of fifty thousand working days, of ten hours each, is effected. Now this is equivalent to an addition to the actual power of one hundred and sixty-seven men, without increasing the quantity of food consumed; and it should also be remarked that the time of the class of men thus supplied is far more valuable than that of mere labourers."

The above was written when the Manchester railroad was the only one established; the present state of things adds greatly to the interest of the observation.

A teacher ought to have a general knowledge of the ordinary things of life, so as to give a character of usefulness to his teaching, which will interest those who are taught, and also interest the parents who send them.

Short Conversational Lectures, about fifteen or twenty minutes long, will be found a very effective means of instruction. Subjects like the following would naturally suggest themselves:

Truth and falsehood—industry and idleness—sobriety and drunkenness—honesty and the reverse, &c.

In natural history; habits of birds—of animals, their instincts, &c.; or on subjects connected with the occupations of the district—agricultural employments—mining, manufacturing, &c.; on any particular application of substances with which they are acquainted, &c. And when a master is qualified, he might take such as the following:

The atmosphere—as a vehicle of heat and moisture—as a vehicle of sound: rain and clouds, &c., mist and fogs, &c., dew, &c.

To give an idea what is meant by conversational lessons, the following may be taken as illustrations:

A loaf of bread.—The teacher would go on to explain that, the different substances of which it is composed are—the flour of wheat, water, barm, salt; that these again are not simple, but each made up of many elementary substances into which they can be separated.

Flour contains gluten, starch, &c., which form the nutritive part of it as food.

Water can be decomposed into its elements, oxygen and hydrogen—two gases, which can be again reunited to form water.

Salt, of a gas, not colourless like the other gases, but yellow, which cannot be breathed, and a metal, sodium.

Barm, a froth which rises to the top of beer during fermentation. That if the smallest crumb of bread be taken, so small as to be only just visible, it will contain something of all these different elements; that if they divide this again into a thousand pieces, so as not to be visible even to the naked eye, each of these would contain something of all the different elements of the loaf.

Again, when the loaf is cut we see a number of cells of various sizes—how came these there? The barm causes a vinous fermentation to take place in the dough, by which an air, heavier than common air, and called carbonic acid gas, is formed; this, as the dough warms, expands, tries to escape, but the dough, by its tenacity, retains it, and in this way these cells are formed.

Then, again, the number of people it has given employment to before it became bread: from the ploughboy up to the farmer—from sowing up to threshing—from the farmer who takes it to market—the corn-dealer—the miller—the baker.

How beautiful this provision of the Almighty for man's happiness, in making necessary that employment of mind and body which is required for his sustenance, and without which he could not live! what an interest this gives to life! "If a man will not work, neither shall he eat," does more for man's happiness than the thoughtless are aware of; and the labourer who has to earn his bread by the sweat of his brow is, in many instances, a much more happy man than he who, from want of employment, whatever his condition in life may be, spends his time in listless indolence or in frivolous amusement.

The cottage fire.—The fire once lighted: this heat sets free the hydrogen and other gases in the wood and coal; the hydrogen, as it is disengaged, takes fire, is supplied with oxygen from the atmosphere, heats the carbon of

the fuel to such a heat that it readily unites with the oxygen of the fuel and of the atmosphere, and forms carbonic acid. This carbonaceous matter in the flame, heated to a red heat, is the principal cause of its giving out so much light. The flame of hydrogen unites with the oxygen, and produces water—the carbonic acid which is formed, being rarefied, ascends through the chimney into the atmosphere, and then mixes with it—is taken up by the leaves of trees and of plants, or descends with the rains, and is again taken up by the roots—the oxygen of it is again given out by the plants to the atmosphere to support animal life—the carbon retained in its solid state, and assimilated to themselves by the trees, adding to their solid state, and again comes back when the trees are cut down to supply us with timber, fuel, &c.

The heat of the fire not being sufficient to cause all the carbon of the fuel to combine with oxygen, the combustion is, as it were, incomplete—the uncombined carbon rises in the shape of smoke, and is partly deposited on the sides of the chimney, and is collected for manuring our lands, and again used up for vegetable life; that part of it which ascends into the atmosphere is washed down by the rain, and so feeds the plants again.

How beautiful to watch the ascent of the smoke on a calm summer's evening—sometimes ascending merrily, denoting fine weather, at another descending the moment it has left it: ascending because the specific gravity of the air is greater than that of the smoke; standing still, and in a sort of stable equilibrium on a calm evening, when the stratum of air in which it is floating is of the same specific gravity as itself; and descending when the specific gravity of the air is less than that of the smoke!

Here we see, in this apparent destruction of vegetable matter, that nothing is lost; the gaseous part which went up the chimney, and which forms a very great proportion of the whole, returns again to nourish vegetable and animal life; the ashes which remain, and contain the inorganic part of the fuel, are spread upon the ground to be dissolved through the agency of water and of the atmosphere, and so carried into the roots for the nourishment and support of fresh vegetable matter. Not the slightest particle is lost, and if all the products of the combustion were collected—the water, carbonic acid, smoke,

ashes—and weighed, their weight would be found greater than that of the fuel, having been increased by the oxygen taken from the atmosphere during the combustion.

The *flame of a candle* might be the subject of two or three conversational lectures of this kind—showing the way in which the tallow or wax, when reduced into a fluid state by heat, ascended by capillary attraction up the wick, a length of which between the candle and the flame will be seen to be moistened with it; a higher degree of temperature changes this out of a fluid into a gaseous state, consisting of the different elements of the substance of the candle, one of which, hydrogen, ignites, the oxygen of the atmosphere supporting the flame, and the carbon, another element, ascending in the flame, and being heated, increases the quantity of light. The products of this combustion, water and carbonic acid, may be collected by placing a funnel-shaped glass tube, with the larger end over the flame of the candle, and the smaller one bent and communicating with a glass cylinder kept cool, in passing into which the watery vapour arising from the flame would be deposited, and the carbonic acid passing on might be collected by an apparatus properly arranged at the other end of the cylinder, and then tested.

It has been found that the water produced by the burning of a candle is nearly equal in weight to that of a candle consumed; the collected products would be greater than this weight, but it will at once be seen that the oxygen of the atmosphere consumed explains this:—the gas collected when properly tested will be shown to be carbonic acid.

That the vapour arising from the burning of a candle or a jet of hydrogen contains a great deal of water is easily shown, by holding a cold glass in such a direction that the ascending vapour may pass into it—the glass immediately becomes dim and wet—the same may be shown by holding a cold glass over a burning piece of cotton—of paper—or a splinter of wood.

Reason why the glass should be cold.

Again, that metals, such as lead, iron, &c., in a minute state of division, are much more inflammable than tallow, oil, fat, &c., or even than gunpowder, taking fire at the temperature of the atmosphere—sodium and potassium igniting the moment they come in contact with water or with ice—and if spirits of wine in a saucer or similar vessel be set on fire, iron filings

thrown on the flame will burn and fall into the saucer, when they can be examined and will be found oxydized, but grains of gunpowder thrown into the flame in the same way will not ignite.

Tallow, oil, and fat require to be heated up to a certain point, when they readily burn, but must wait to be artificially heated before they do so—how beautiful this provision in order that they may be turned to the purposes of mankind—lighting their dwellings—enabling them to read—to work;—how important all this to civilized life!—and while we consider all these things "do not let us forget Him who made them."

In giving a short conversational lecture on birds, for instance, the teacher might speak of the way in which they build their nests—whether in trees or on the ground—the greater degree of skill shown by some in doing this, than by others—but that all birds of the same kind build in the same way—that a bird builds its nest by instinct—man builds a house from reason, improves and profits from what others have done in that way before him—but that birds build now as they always have done, &c.

The striking difference of the state of their young, when hatched and leaving the egg—the chickens of the barn-door fowl, and of others of that class, will run about, and seek their own food the moment they leave the egg—want but little assistance from the parent birds, that of the mother alone for a short time being quite sufficient, and the care of the male bird is not wanted in assisting to bring up a brood of chickens—the same with the duck—young ducks take to the water, and look out for themselves immediately.

Others, again, such as birds of prey, the eagle, the hawk—all our small birds—the young of these, after leaving the shell, are in a helpless state for some weeks, and depend entirely for support upon the parent birds, and require the assistance of both, in order to find a sufficient supply of food: these are always found in pairs, and want the assistance of both the parent birds to bring them up.

Then the structure of the bones—being hollow tubes, and full of air-cells—caused by little, strengthening, bony processes, which go from one side of the hollow tube to the other—(this would be seen by splitting the bones of fowls)—the outside bony substance of the tube being thickest at the extre-

mities, where strength is wanted—all this required for the purposes of flight; but in the bones of animals moving on the ground, these hollow parts of the bone are filled with marrow—fewest air-cells in the bones of those birds whose habits do not require long flight, &c. The mechanical structure of the wing—the pinion-bone moving in order to stretch out the feathers in the same plane with the one to which it is attached—if it admitted of an up-and-down motion out of that plane, the wing would be much less strong, and a much greater muscular power required to produce the same effect in flight, &c.

Again, on fish for instance—some breathing by means of gills, so as to get at the oxygen contained in the air of the water, all water containing air, it being necessary to the life of fish. Air contained in water being richer in oxygen by about 25 per cent. than the air of the atmosphere—this is important to fishes—although cold-blooded animals do not require by any means the same amount of oxygen in a given time as hot-blooded ones of the same size—perhaps not more than $\frac{1}{50}$th.

Some fish, such as the whale, &c., breathe by means of lungs, and take in air, for which purpose they are obliged to come up to the surface of the water.

All air-breathing fishes have a broad flat tail—a horizontal tail, giving them a mechanical advantage in rising to the surface—fishes breathing through the gills have the tail vertical, perpendicular to the water in which they float—thus to propel them forward and direct their motion—some fish, gelatinous masses, breathe at all points of their surface.

One reason why some fish live longer than others out of water, seems to arise from their having a different kind of gill, one which retains a quantity of water, and so long as they can get oxygen from this water in the gills they continue to live.

Any one wishing to give short conversational lectures of this kind, if unaccustomed to do so, will find it of assistance to read from a book any striking passage which may occur, or which he may happen to meet with in his own reading, embracing facts easy of illustration, or describing the manners and customs of other nations; such, for instance, as the following:

"Certain insects can run about on the surface of the water. They have brushy feet, which occupy a considerable surface,

and if their steps be viewed with a magnifying glass, the surface of the water is seen depressed all around, resembling the footsteps of a man walking on feather-beds. This is owing to a repulsion between the brush and the water. A common fly cannot walk in this manner on water. Its feet are wetted, because they attract the water instead of repelling it. A steel needle, slightly greased, will lie on the surface of water, make an impression as a great bar would make on a feather-bed, and its weight is less than that of the displaced water. A dewdrop lies on the leaves of plants, without touching them mathematically, as is plain from the extreme brilliancy of the reflection at the posterior surface; nay, it may sometimes be observed, that the drops of rain lie on the surface of water, and roll about on it, like balls on a table. Yet all these substances can be wetted; that is, water can be applied to them at such distances that they attract it."

How easy to make interesting remarks on a passage like this, and how delighted children are to have the philosophy of such things as flies walking on water, or needles floating on it, explained to them—or of any facts which come frequently under their own observation.

I have been very much pleased with the interest I have found the children would take in having any graphic passage read to them, descriptive of the modes of life, occupations, &c., of other nations or people, and have occasionally read passages of that kind myself, and am in the habit of pointing out such to the school-teachers to read. I will instance the following: while reading 'Hochelaga,' a description of Canadian life, the following passages occurred to me as giving a lively picture of what it is their object to describe, and one quite coming home to the minds and capacities of children. I took the book into the school, and read them, and the interest with which they were listened to, with a few observations I made myself, would have convinced any one of the usefulness of this suggestion. On an occasion like this, the teacher would, as an economy of time, unite all the intelligent part of his school.

"For about three weeks after Christmas, immense numbers of little fish, about four inches in length, called 'tommy-cods,' come up the St. Lawrence and St. Charles: for the purpose of catching these, long narrow holes are cut in the ice, with comfortable wooden houses, well warmed by stoves, erected

over them. Many merry parties are formed, to spend the evening fishing in these places; benches are arranged on either side of the hole, with planks to keep the feet off the ice; a dozen or so of ladies and gentlemen occupy these seats, each with a short line, hook, and bait, lowered through the aperture below into the dark river. The poor little tommy-cods, attracted by the light and air, assemble in myriads underneath, pounce eagerly on the bait, announce their presence by a very faint tug, and are transferred immediately to the fashionable assembly above. Two or three Canadian boys attend, to convey them from the hook to the basket, and to arrange invitations for more of them, by putting on bait. As the fishing proceeds, sandwiches and hot negus are handed about, and songs and chat assist to pass the time away. Presently plates of the dainty little fish, fried as soon as caught, are passed round, as a reward of the piscatorial labours. The young people of the party vary the amusement, by walking about in the bright moonlight, sliding over the patches of glassy ice, and visiting other friends in neighbouring cabins; for while the tommy-cod season lasts there is quite a village of these little fishing-houses on the river St. Charles.

"Although the temperature is usually kept very high within doors, by stove-heat, people never seem to suffer by sudden transition to the extreme cold of the open air. I have often seen young ladies, when the thermometer was below zero, leave a hot room, where they had been dancing, and walk quietly home, with very little additional clothing; the great dryness of the air preserves them from danger. In the very low temperatures, a razor may be exposed all night to the air without contracting a stain of rust. Colds are much less frequent in winter than summer."

"The winter markets at Quebec are very curious: everything is frozen. Large pigs, with the peculiarly bare appearance which that animal presents when singed, stand in their natural position on their rigid limbs, or upright in corners, killed, perhaps, months before. Frozen masses of beef, sheep, deer, fowls, cod, haddock, and eels, long and stiff, like walking-sticks, abound on the stalls. The farmers have a great advantage in this country, in being able to fatten their stock during the abundance of summer, and by killing them at the first cold weather, keeping them frozen, to be disposed

of at their pleasure during the winter. Milk is kept in the same manner, and sold by the pound, looking like lumps of white ice."

The above passages will suggest many interesting observations on the habits of the people, climate, &c.; that, although ice is ice, yet it varies in its temperature, and that a mass of ice (milk) at a low temperature (zero, for instance,) would do more for cooling purposes, than the same mass at a temperature near the melting point. Canadian ice is better than English ice, and why?

Then, again, these frozen animals, &c., how is it that the animal body, while alive, is not cooled down to the temperature of the atmosphere, and of the objects around it?—what is it which maintains this internal heat that resists the cold?—a degree of cold in some climates far below the zero of Fahrenheit, and preserves an internal temperature in warm-blooded animals, varying but little on either side of 96°—remaining also about the same in the hottest climates—refusing to be cooled down by surrounding objects below that internal heat which is necessary for this class of animal life, or to be heated by those above it; but the moment life is extinct yielding itself up to the influences of either—in the one case becoming a solid frozen mass, and while in that state not decomposing—and, in the other, rapidly dissolving into its simple elements.

And again: Is every kind of animal life equally affected by heat?—are those termed cold-blooded animals affected in the same way as the warm-blooded by the surrounding media?—No: these submit themselves within certain limits to the influence of the surrounding objects, and the internal heat of their bodies varies between 35° and 85°—when cooled down to the former point many of them become torpid—and revive again with increased warmth, but all refuse to be cooled below this, the principle of animal life supporting the heat of the body at this temperature—how curious this is, when, for months together, no new fuel is added to support this heat. In hot climates, if they submitted to a heat greater than about 85°, they would, many of them, dissolve and become extinct—these preservative conditions are indeed beautiful.

What myriads of organisms necessary for the chain of existences in the world would be destroyed if either of these principles were violated!

The SINGING of the children here has been a good deal remarked upon, as being better than is usually found in schools of this kind, particularly in the country. I have myself witnessed, with great pleasure, the good moral effect, and at the same time cheerful feeling, which this gives rise to among them. They are taught by one of the parishioners, who, although busily engaged in other things, finds time to instruct the children of his neighbours; and has that pleasure in doing good to others which every well-regulated mind ought to feel. During the winter they meet every Wednesday evening at the class-room, which is well lighted and warmed, where I occasionally attend myself, and always with feelings of satisfaction, in seeing sixty or seventy children (which is the number of the singing class) spending the evening in so rational a manner. In addition to Psalmody, they sing in parts many of the moral pieces in Hullah's books, as well as others, not forgetting Rule Britannia, and God Save the Queen, and have as loyal hearts as any in her Majesty's dominions.

SCHOOLMASTERS.

Having spoken of the kind of knowledge which I conceive is the most useful to be introduced into our schools, and the mode of teaching it, I will add a few observations bearing upon the duties of the schoolmaster, and the course of education, which I trust may not be altogether without interest.

At present I fear these duties are not sufficiently understood, and that society at large does not attach the importance to them which it ought to do; but as the people become better educated they will, it is to be hoped, attach greater value to the services of the schoolmaster. In the meantime he must expect to meet with difficulties, and to find hinderances where he might have looked for support, and altogether to find the road not so smooth as he had calculated upon.

So long as there are those who prefer darkness to light—an ignorant peasantry to an enlightened one—who look upon the labourer as a machine which sleep winds up at night, to be set again in motion in the morning, and again run down on doing its daily work—who think he has sufficient knowledge of the world if he knows the order of succession in which the days of the week come—and that although God has given to

the labourer a mind, it was not intended he should exercise it, it was only the body which was made for his use—so long will there be hinderances in the way of education, and it will have to struggle against opinions, and against difficulties arising out of them, which may for a time impede its progress, but must in the end give way.

But it is not learning alone which will make an efficient schoolmaster and overcome these difficulties; there are many other requisites of a personal nature, which, if he does not naturally possess, he must endeavour to acquire. He must not only teach by precept but by example; anything he can say will have comparatively little effect, if he is an example of the direct contrary in his own conduct.

With respect to punishment, the less of severity the better—he should endeavour to win over the children by kindness and good temper, reasoning with them in a cheerful way, and always endeavouring to discriminate, as far as possible, between idleness and want of ability. When two children are set to do the same thing, such as getting by heart a piece of poetry for instance—it may be a very unequal task—he should not be angry with a child which has done its best: this is an error I have often seen in schoolmasters.

On this point there is an anecdote in Stanley's interesting 'Life of the late Dr. Arnold,' which ought to be registered in the mind of every schoolmaster in England. At Laleham (the place where he lived), he had once got out of patience and spoken sharply to a pupil, who was a plodding boy, and had taken great pains; when the pupil looked up in his face, and said, "Why do you speak angrily, sir? indeed, I am doing the best I can." Years afterwards he used to tell this story to his children, and said, "I never felt so much ashamed in my life; that look and that speech I have never forgotten." This requires no comment, it speaks both to the feelings and to the understanding. Mr. Stanley adds, that he used to say, "If there be one thing on earth which is truly admirable, it is to see God's wisdom blessing an inferiority of natural powers, where they have been honestly, truly, and zealously cultivated."

In teaching children habits of cleanliness, the schoolmaster will have great difficulty if he does not set an example in his own person; he should not go into the school unshaved, as I see many do: this has a dirty and a slovenly appearance.

He should endeavour to make them open and straightforward in their conduct, and on all occasions to speak the truth—to get rid of all those feelings of low cunning which are too prevalent in the labouring classes—to be an example himself of open, manly, and straightforward conduct. He must not attempt to despise others for conduct which he himself is guilty of.

He should set an example of industry, thriftiness, and good management in his own household; by this he will gain the good opinion of those around him, and very much increase his power of doing good.

In his religious teaching he should impress upon them, and show it in his own conduct, that Scripture truths are not intended as mere idle words, always in their mouths and little thought of, but are intended to be acted upon.

The following passage from a paper of Addison's in the Spectator conveys an instructive lesson, and requires no comment:

"It is of unspeakable advantage to possess our minds with an habitual good intention, and to aim all our thoughts, words, and actions at some laudable end, whether it be the glory of our Maker, the good of mankind, or the benefit of our own souls.

"A person who is possessed with such an habitual good intention, enters upon no single circumstance of life without considering it as well pleasing to the great Author of his being, conformable to the dictates of reason, suitable to human nature in general, or to that particular station in which Providence has placed him. He lives in a perpetual sense of the Divine presence, regards himself as acting, in the whole course of his existence, under the observation and inspection of that Being, who is privy to all his motions and all his thoughts, who knows his 'down-sitting and his up-rising, who is about his path and about his bed, and spieth out all his ways.' In a word, he remembers that the eye of his Judge is always upon him, and in every action he reflects that he is doing what is commanded or allowed by him who will hereafter either reward or punish it. This was the character of those holy men of old who in that beautiful phrase of Scripture are said to have 'walked with God.'"

Some of these observations may appear trite and common-

place, and I will not go on adding to them. The schoolmaster ought to see and feel that life is made of little things—that man is a "bundle of habits," and that it is therefore of importance he should acquire good ones in youth, and that although each single thing may not of itself appear of importance, it is only by attending to each separately that good as a whole, and in the aggregate, can be produced—that it is only by impressing upon the minds of children over and over again, by example and by precept, the importance of these little things and these little duties (in addition to other instruction which he has to give), that he can work out a good result, and discharge those duties to society which are expected from him.

CONCLUDING REMARKS.

In having put forward these views on the subject of secular instruction in our schools, I hope it will not be supposed that I am either indifferent, or would give less attention than ought to be given, to those Scriptural truths which are the foundation of all sound teaching, and without which an education of a mere secular kind may be a very delusive guide.

In the middle and educated classes, a religious foundation may generally be laid at home, but with the labouring and uneducated classes this can hardly be said to be the case. My own experience tells me that the more they have of secular knowledge—the more they know of their own language, the grammar of it, &c., so as to get at the construction of a sentence, the better they will understand, and the greater interest they will take in those fundamental truths of Christianity which it is essential for them to know, and without which they cannot even be called Christians—truths which they ought to know and believe for their souls' health; the more also they will feel that the precepts of the Gospel are intended for their guidance through life—to be acted upon, and not merely to be talked about—to guide their thoughts and words and actions—and that, if they do not take them as their guide, and, by God's help, endeavour to act up to them—whether they belong to the church or dissent from it—they are merely nominal Christians, and might as well be called by

any other name. That if religion does not make them better in all the relations of life, as parents doing their duty to their children and all around them—as children* obedient to their parents, grateful to them in after-life, truthful and honest in all they do—so far as they are concerned, it has failed in its intention, and that they are not doing what they profess they ought to do. That practical good conduct is the best proof which they can give that they believe what they profess—that the same substance of Christianity is contained in that beautiful passage from St. Paul, which cannot be too often or too deeply impressed upon their minds, "The grace of God that bringeth salvation hath appeared unto all men, teaching us that, denying ungodliness and worldly lusts, we should live soberly, righteously, and godly in this present world; looking for that blessed hope and the glorious appearing of the great God, and our Saviour Jesus Christ, who gave himself for us that he might redeem us from all iniquity, might rescue us from the power and dominion of sin, and purify unto himself a peculiar people, *zealous of good works*;" and that they ought to endeavour to acquire the virtues, the temper, and disposition of a real Christian.

It has been asserted, "that man acts more from habit than from reflection," and of the truth of this no one can doubt—but how important then that, in the education of youth, the training of the mind should be such as to influence for good the habits which are then formed, and on which the character of the man so much depends; not only should he be made to feel that, in a worldly point of view, his

* And canst thou, mother! for a moment think
That we, thy children, when old age shall shed
Its blanching honours on thy drooping head,
Could from our best of duties ever shrink?

Sooner the sun from his high sphere should sink,
Than we, ungrateful, leave thee in that day
To pine in solitude thy life away,
Or shun thee, tottering on the grave's cold brink.

Banish the thought! where'er our steps may roam,
O'er smiling plains, or wastes without a tree,
Still will fond Memory point our hearts to thee,
And paint the pleasures of thy peaceful home;
While Duty bids us all thy griefs assuage,
And smooth the pillow of thy sinking age. H. K. White

success and his respectability in after-life depend upon the habits of industry, of manly virtue, and of honest, straightforward conduct, the groundwork of which is laid at this period of life—but that all his actions and all his feelings should partake of the spirit and of the devotional feeling which sees, as one of our sweetest poets has beautifully expressed it—

"There lives and works
A soul in all things, and that soul is God.
Happy who walks with him! whom what he finds
Of flavour, or of scent, in fruit or flower;
Or what he views of beautiful or grand
In nature, from the broad majestic oak
To the green blade that twinkles in the sun,
Prompts with remembrance of a present God."

Not that children should be made to feel that there is anything gloomy in religion, or in those feelings which spring from viewing the works of nature in a devotional spirit; on the contrary, I should wish to have them taught to look on the cheerful side of things, and to find lessons of happiness in the works of nature which are around them—

Behold! and look away your low despair—
See the light tenants of the barren air:
To them nor stores nor granaries belong;
Nought but the woodland and the pleasing song.
Yet, your kind heavenly Father bends his eye
On the least wing that flits along the sky.
To Him they sing when spring renews the plain,
To Him they cry in winter's pinching reign;
Nor is their music nor their plaint in vain—
He hears the gay and the distressful call,
And with unsparing bounty fills them all.

Observe the rising lily's snowy grace,
Observe the various vegetable race;
They neither toil nor spin, but careless grow;
Yet see how warm they blush, how bright they glow.
What regal vestments can with them compare—
What king so shining, or what queen so fair?
If ceaseless thus the fowls of heaven He feeds;
If o'er the fields such lucid robes He spreads;
Will He not care for you, ye faithless, say?
Is he unwise?—or are you less than they? THOMSON.

Paley, in his 'Natural Theology,' after having inquired into the works of nature, comes to the conclusion that "the world, after all, is a happy one;" and, in the sense in which he intended

it, this view is perfectly right, and it ought to be the duty of every teacher to train up the young to see and contemplate the goodness of the Almighty in the designs of creation—to see in everything "that happiness is the rule, and misery the exception"—to contemplate with pleasure "the air, the earth, the water teeming with delighted existence;" he goes on to say, "In a spring morn or summer evening, on whichever side I turn my eyes, myriads of happy beings crowd upon my view; the insect youth are on the wing: swarms of new-born flies are trying their pinions in the air; their sportive motions testify their joy, and the exultation which they feel in their lately discovered faculties. A bee amongst the flowers in spring is one of the most cheerful objects that can be looked upon; its life appears to be all enjoyment—so busy and so pleased; yet it is only a specimen of insect life, with which, by reason of the animal being half domesticated, we happen to be better acquainted than we are with others. The whole winged insect tribe, it is probable, are equally intent upon their proper employments, and under every variety of constitution gratified by the offices which the Author of Nature has assigned to them. But the atmosphere is not the only scene of enjoyment; walking by the sea-side in a calm evening, upon a sandy shore, and with an ebbing tide, I have frequently remarked the appearance of a dull cloud, or rather very thick mist, hanging over the edge of the water, to the height, perhaps, of half a yard, and of the breadth of two or three yards, stretching along the coast as far as the eye could reach, and always retiring with the water: when this cloud came to be examined, it proved to be nothing else than so much space filled with young shrimps, in the act of bounding into the air from the shallow margin of the water or from the wet sand. If any motion of a mute animal could express delight it was this; if they had meant to make signs of their happiness, they could not have done it more intelligibly. Suppose, then, what I have no doubt of, each individual of this number to be in a state of positive enjoyment, what a sum, collectively, of gratification and of pleasure have we here before our view.

"The young of all animals appear to me to receive pleasure simply from the exercise of their limbs and bodily faculties. A child is delighted with speaking, without having anything to say, and with walking without knowing where to go; and, prior

to both these, I am disposed to believe that the waking hours of infancy are agreeably taken up with the exercise of vision, or perhaps, more properly speaking, with learning to see."

How desirable, nay, how enviable is that frame of mind which can reason thus, and find sources of happiness in watching the habits of the animal and vegetable world around them! that can see only happiness in an action, which appears at first sight to have no meaning, the leaping of a cloud of shrimps from the water; and where an uninquiring mind, or one of a gloomy temperament, would merely say, this is to avoid the danger of falling into the jaws of some fish-monster which is below the surface.

> "These are thy wondrous works, first source of good!
> Now more admired in being understood."

Who can listen to the carol of the lark as he soars in the air, and seems so happy, without feelings of delight and without reflections rising in his mind which tend to make him both a better and a happier man?—Who can witness the familiar habits of the robin, and see how contentedly he will perch himself on a neighbouring bush close to your side, and pour forth his song, without having his own feelings tempered down into harmony with nature?—How can man in the midst of all this, which points out the intention of an all-wise Creator, think that he of all God's creatures is the only one intended to be unhappy!

No!—let him learn to admire the beauties of nature—let him learn to occupy his hours of leisure in trying to understand them—to find

> "Tongues in trees—books in the running brooks—
> Sermons in stones—*and good in everything*."

> *Nature* never did betray
> The heart that loved her; 'tis her privilege,
> Through all the years of this our life, to lead
> From joy to joy: for she can so inform
> The mind that is within us, so impress
> With quietness and beauty, and so feed
> With lofty thoughts, that neither evil tongues,
> Rash judgments, nor the sneers of selfish man,
> Nor greetings where no kindness is, nor all
> The dreary intercourse of daily life
> Shall e'er prevail, that all which we behold
> Is full of blessings. Therefore let the morn
> Shine on thee in thy solitary walk;

And let the misty mountain winds be free
To blow against thee; and, in after years,
When these wild ecstasies shall be matured
Into a sober pleasure, *when thy mind*
Shall be a mansion for all lovely forms,
Thy memory be a dwelling-place
For all sweet sounds and harmonies; oh! then
If solitude, or fear, or pain, or grief,
Should be thy portion, with what healing thoughts
Of tender joy wilt thou remember me,
And these my exhortations! WORDSWORTH.

Nature, enchanting Nature, in whose form
And lineaments divine I trace a hand
That errs not, and find raptures still renew'd,
Is free to all men—universal prize!
Strange that so fair a creature should yet want
Admirers, and be destin'd to divide
With meaner objects ev'n the few she finds. COWPER.

How important the bearing and influence which such trains of thought, inculcated in youth, might have in every class of life it would be wise to consider; how little they have hitherto had, is humiliating to think. A dry remark, many years ago, in a college lecture-room, occurs to me as full of meaning, although at the time intended for sarcasm. Asking an undergraduate a question on the refraction of light, with which he was not acquainted, and who answered, "he did not know much about refraction," the lecturer dryly added, "nor about reflection either, I am afraid." I hope this will not be lost upon the schoolmaster; not that I wish him to make his remarks in the same spirit.

That the sphere of enjoyment of the labouring and middle classes might be enlarged by education there can be no doubt, and it was observed by a celebrated moralist, more than a century ago, that "man in all situations in life should endeavour to make the sphere of his innocent pleasures as wide as possible, that he may retire into them with safety, and find in them such a satisfaction as a wise man would not blush to take; for although the world may not be so happy as that we should be always merry, neither is it so miserable as that we should be always melancholy."

With respect to that part of the instruction in the foregoing pages which is of a scientific kind, I would say, and I do so from a feeling of conviction which experience gives, that in no

way can the teachers in our higher class of elementary schools give such a character of usefulness to their instruction, as by qualifying themselves to teach in these subjects; introducing simple and easy experiments, which illustrate the things happening before their eyes every day, and convey conviction with them the moment they are seen and explained. It is a great mistake to suppose that boys of twelve and thirteen years of age cannot understand elementary knowledge of this kind, when brought before them by experiment;—seeing the way in which the bigger boys were interested in it here, and the tendency it had to raise the standard of teaching, and to give rise to a wish for information, it has proceeded further than I at first contemplated—the result has been, that the school is provided with sufficient of a philosophic apparatus* for all the common experiments of a pneumatic and hydrostatic kind, a small galvanic battery, an electric apparatus, &c. One little book used as a text-book is a volume of Chambers's Edinburgh books, 'Matter and Motion,' and this is illustrated by experiment.

The end of all education ought to be, to prepare them for those duties and those situations in life they are called upon to fulfil—whether they be "hewers of wood or drawers of water," of those who belong to the labouring, the middle, or the upper classes in life, to make them in their respective stations good citizens and good Christians; and I think it will be found that, according as a teacher keeps this in view, making his instruction bear upon the ordinary duties of life, or loses sight of it (I am speaking of a teacher competent to his work), he will succeed, or the contrary. I am perfectly convinced that many well-meaning efforts have not been attended with the success expected from them, entirely owing to their leaving out all instruction relating to the occupations by which they were, in after life, to earn their bread.

Although these hints are addressed to the schoolmaster, I am not without hope that they may be of some use to many in my own profession, and to others who take an interest in advancing the happiness and respectability of the uneducated classes in this country.

The schoolmaster, especially in the present state of things, is not able to do all that is wanted. He is very often insufficiently educated himself—his social position is not what it

* See Appendix (C.)

ought to be—the poor are inclined to resist his authority over their children—to send impertinent messages through them, &c., so that, at first, he wants strengthening in these respects. Then, again, the more wealthy do not place him in that scale of society that he ought, from his usefulness, to be placed in.

In saying this, I am not seeking for him a better position than the interests of society require that he should have, and which, in the end, his own usefulness will work out for him; —there is no doubt that the schoolmaster who conducts himself well—who can succeed in raising the standard of education in his school, and in making it what it ought to be, and what it hitherto has not been, a benefit to all classes around him—will establish claims upon all, the labourer, the tradesman, and the farmer, and upon all in his locality, which will cause him to be estimated in a very different way, and place him in a very different position from that which he has hitherto held. At present, ignorance, and jealousy arising from it, produce in many of the uneducated a sort of dislike to all the instruments of education—a sort of jealous feeling, the result of which is to endeavour to bring all those leaving school to a level with themselves—to make them mere masses of clay, animated, it is true, but in every other respect a mere "bundle" of ignorance.

Notwithstanding all the difficulties with which education is beset, but which must prove less and less every year, I hope many of those who persevere in this useful work may live to see the labouring classes of this country much more enlightened than they are at present—much more respectable in their conduct—honest, manly, and straightforward in everything they have to do—not looking upon insolence as independence, which ignorance does, but feeling that it is a duty which they owe to themselves to be respectful to their superiors, civil and obliging, neighbourly and kind to all about them, and that, when they fail in these things, they are wanting in their duty both to God and man.

It is painful to observe how the uneducated classes, the labourer and those above him, will sometimes, from pure ignorance of what is due to themselves, go out of their way to insult others, from a feeling that this is, as they call it, showing their independence. When I see this, I am always sorry that it does not occur to them, that in doing so they are only lowering themselves in the scale of humanity and of

civilization, and that feelings of self-respect ought to deter them from it; education will teach that it does not, at least ought not, to belong to civilized life.

As a means of animating those who, from their situation in life—from their education or their position, may have it in their power to assist in advancing the cause of education in their own neighbourhoods, I can only say, if they once experience the heartfelt satisfaction which arises in contrasting the state of the educated child with that of the totally uneducated one—the intelligent countenance of the one, with the stolid, unmeaning countenance which ignorance produces in the other—the good effect of education on their industrial habits—on their social habits—(in fact, so far as my own experience here goes, and judging from those who have left school, it makes them, generally speaking, a totally different race of beings),—they will not hesitate as to the course they ought to pursue.

It may not be consistent with the occupations of those engaged in a very busy and active life to pay much attention to the education of those among whom they live, yet there are many ways in which they may give encouragement to it and to the schoolmaster without much encroachment upon their time. They are many of them alive to the beauties of Nature—they can enjoy the growth and expansion of a flower—watch each petal unfold itself, and look with pleasure to its full opening and beauty—watch it from its blossom to its fruit—why, not, then, take some interest in the opening and expansion of the human mind?* What can be more gratifying to the feelings, than seeing its gradual improvement under your

* "The natural state of man must be reckoned, not that in which his intellectual and moral growth are stunted, but one in which his original endowments are, I will not say brought to perfection, but enabled to exercise themselves, and to expand like the flowers of a plant; and especially in which that characteristic of our species, the tendency towards progressive improvement, is permitted to come into play.

"A plant could not be said to be in its natural state which was growing in a soil or climate that precluded it from putting forth the flowers and the fruit for which its organisation was destined. No one who saw the pine growing near the boundary of perpetual snow on the Alps, stunted to the height of two or three feet, and struggling to exist amidst rocks and glaciers, would describe that as the natural state of a tree which, in a more genial soil and climate a little lower down, was found capable of rising to the height of fifty or sixty yards. In like manner, the natural

influence, and that you are rendering it capable of using those reasoning powers with which it is endowed, and which are intended as the source of its highest gratification?

That there are many among those who have paid attention to the subject of education, both of my own profession and others, who have fears of doing too much—some for one reason and some for another—there is no doubt; but if they will only look a little further into it, and see what can practically be done, and what, in those instances where most has been doing, is the good effect upon their conduct, I am well assured they will find no ground for fear.

The cry that it is teaching too much—it is teaching them astronomy, mathematics, &c., is very high sounding, and implies much more than can be done, or even is attempted; then, again, consider the small number who remain even for this;—but the fact is, it is not teaching them astronomy, &c., but it is merely making them acquainted with facts in those subjects of a scientific kind which they are capable of understanding—which will be verified afterwards by their own experience—which open their minds, and bear upon their occupations in life—facts most useful and interesting to them, and which, even independent of their usefulness, give a greater interest to education than can be given in any other way.

It might as well, and with as much truth, be said that floating a small paper boat on a tub of water was teaching them navigation;—besides, why assume that knowledge, when communicated to the lower orders, must necessarily have a tendency to evil?—why imagine that a boy who is told how the sailor steers by the compass, and who knows a little of geography, will run away to sea and become a Paul Jones, a buccaneer, or a pirate, rather than, if he does so, that he will run in a right course—go to China, or join Mr. Brooke in Borneo, and help to civilize the world. But even in Shakspeare's

state of man must, according to all fair analogy, be reckoned, not that in which his intellectual and moral growth are, as it were, stunted and permanently repressed, but one in which his original endowments are, I do not say brought to perfection, but enabled to exercise themselves and to expand like the flowers of a plant; and especially in which that characteristic of our species, the tendency towards progressive improvement, is permitted to come into play. Such seems to have been the state in which the earliest race of mankind were placed by the Creator."—ARCHBISHOP WHATELEY'S *Introductory Lectures on Political Economy.*

time there seems to have been those who objected to much being done in this way, although I think there are few at present who would quite adopt the words which he puts into the mouth of Jack Cade, in his Henry the Sixth: "Thou hast most traitorously corrupted the youth of the realm in erecting a grammar school; and whereas, before, our forefathers had no other books than the score and the tally, thou hast caused printing to be used; and thou hast built a paper-mill. It will be proved to thy face that thou hast men about thee that usually talk of a noun and a verb, and such abominable words as no Christian ears can endure to hear."

In presenting this outline of secular teaching in our elementary schools, I have done it with a view to its helping to an improved system, and towards what I think most important at the present time, the establishing schools combining the education of the labouring classes with those of the employers. This has been the aim which I had in the one here, and it is, in my opinion, one of its most important and leading features, and has in this respect been completely successful.

The number in the school when visited by the Rev. H. Moseley, her Majesty's Inspector, in March 1847, was 173, and their average ages throughout the school—boys, ten years and three months—girls, ten years and eight months; and although many of the labourers' children remain considerably beyond the usual ages in schools of this kind, yet, generally speaking, they leave between ten and eleven, and many even before that. It appears from the report of Mr. Moseley, in 1845, that the average age of the *monitors* in the numerous schools which he inspected is not more than eleven years.

The number of children at present (April 1848) in the school is upwards of 180, in addition to which there is a small infant school of about thirty children, kept in a cottage hard by, and managed in turn by the girls who are pupil-teachers: from this it would appear that a very large proportion of the population is at school, being upwards of a sixth of the whole, but about thirty are from neighbouring parishes.

The proceeds of the school for the year from Christmas,* 1846, to Christmas, 1847, were £152 2*s.* 2*d.*, this includes books, the payments for which during the year by the children amounted to £29 14*s.* 6*d.* This is a sure test of the value which the parents attach to the education their children are getting.

* See note to the next page.

It is now advanced in its sixth year,* and, having watched the working of it in all its bearings, from the first, with a great deal of attention, I feel that I may, with some degree of confidence offer a few observations, in addition to those I published in a pamphlet entitled *Hints towards a Self-Paying System of Education.*

The reception the pamphlet met with, and the number of attempts which are being made in the same direction, and which I hope may meet with the same success, have in some measure led to this publication. I there stated, that schools for the education of the children, both of the labourer and employer, might be very extensively established in the larger parishes throughout England, by the assistance of the clergy and others interested in the education of the poor: this I still repeat, and with increased conviction of its truth. I repeat this passage from knowing that it has been misquoted and reasoned upon as if I had said in all parishes—a thing manifestly impossible in small ones—but these ought, and no doubt would, for the bigger children, take advantage of the neighbouring schools.

Increased experience has confirmed what I then stated, that the better the labouring classes are educated, the better they will become in all the social relations of life, and that no great improvement can be effected in the manners of the people but by the education of the rising generation.

"It is difficult, if not impossible, to change the habits of men whose characters are formed and settled. The prejudices of ignorance that have grown up with them will not yield to new impressions, whilst youth and innocence may be moulded into any form you may choose to give them."

There is one class of men in our rural districts, and no doubt a similar class in towns, to whom schools of this kind are the greatest possible boon, the tradesmen and smaller farmers. Hitherto they never have had an education for their children within their reach, but when it is so, they show themselves willing and anxious to profit from it.

* The school is now in its eighth year, with the same satisfactory results, both pecuniary and moral, and an increasing conviction of its usefulness to all classes: the quarterly payments and pence for the year ending with Dec. 1848, were £115 19*s.* 2*d.*; and for books for the same time, £25 9*s.*; for the year ending with Dec. 1849, £123 7*s.* 7*d.*, and for books, £39 18*s.* 2*d.*; in addition to which, during the last year, the children have purchased tooth-brushes, hair-brushes, combs, scissors, &c., to the amount of £3 14*s.* 2*d.*

With respect to the more wealthy farmers, and also professional men living in the country, many of them will, as they do here, send their children to these schools, if well conducted, when they see it is an advantage to them to do so. It would be folly to suppose that any prudent parent would hesitate to send his children when a good education is to be had at them, at a comparatively small expense, merely because their primary object was the education of the poor, and when he sees clearly that the interests of both classes may be advanced by his doing so.

The gradual improvement of the labouring classes will be such, and also of the class immediately above them, that each will see their true interests in a better light than they have hitherto done, and there will be no longer that fear of coming in contact with each other in early life which there has been, and which has been productive of anything but good.

That the occupying farmers as a class, and I speak of them more particularly from not having much knowledge of the employers of labour in towns, are against the education of the labourer, there is no doubt; for they seldom speak of it in any other terms than as "a parcel of stuff, a parcel of nonsense; what do they mean by attempting to teach the children all this;—we shall not be able to get labourers," &c. All this is mere prejudice, and will soon die away.

One objection running in the minds of many of them is this (a most ungenerous one it is true), that the children of the labourer in schools like the one here—for I know it has been urged against this—are getting, at a cheap rate, a better education than those of the farmer. Now this would be true, supposing that the class above the labourer were to remain stationary as to education, a thing they will not do, as they will no doubt in the end, act upon the principles of common sense, and take advantage of such schools, where they are established in their parishes or in their neighbourhood.

For what is the way in which it operates here? From the above averages as to age, it is evident that the children of the labourer leave between ten and eleven, many of them earlier; those who stay after that age are exceptions to the general rule.

Now surely this is not staying to an age at which any one can justly take alarm; yet I know that, even at this age, some

of them are better educated than the children of many of the farmers have hitherto been; but in keeping their children at school to the age of fourteen or fifteen, the latter would secure to themselves their proper place in the social scale, and as it is in their power to do so, if they do not, they have no business to find fault. It has been said, that every class above another teaches that below it, and the establishment of good and cheap schools will not reverse this; on the contrary, strengthen it.

I feel, from my own experience, how much the classes above the labourer and mechanic are interested in a good and efficient system of education in our parish schools, and I wish to open their eyes to the importance of them, and to the good results which would arise, if all would unite in trying to establish schools with a view to meet the educational wants of the age in which we live.

The farmer, and those of the same class in our rural districts, may rest assured, that until it is brought home to them into their own parishes or neighbourhood, they never will, as a class of men, get that education it is desirable they should have; and, that by standing aloof, and feeling no interest in that of the labourer, they only augment the evil which they dread—the one is advancing in intelligence, and it is time it should—the other is standing still; and I cannot but think, that in a very few years, the employers of labour will be the class which, of all others, will take the greatest interest in those very schools of which they now think so little.

It is a remark sometimes made, that the Physical Condition of the Labouring Classes, particularly as regards the crowded state of their cottages, is such as to render attempts to educate almost fruitless, or at all events to be a very great hinderance to it.

In this there is no doubt much truth, for it will generally be found, that when families are crowded together into a small space—all ages and sexes sleeping in the same room—that they lose all sense of decency and respectability, and that education in such cases has great difficulties to contend with.

The remedy for this, with regard to the cottages in our rural districts, rests with the landlords rather than any one else—the farmer is indifferent to it—one sleeping-room for a family however large, satisfies him.

The system of letting cottages in a wholesale way with farms, beyond what is necessary for farm servants, and of letting out leasehold and lifehold cottages for the purpose of subletting, is one very much to be condemned, and which calls for the consideration of the landlords of this country. They have it in their power to do much good in this, and the mischief has arisen from want of attention on their part, and not in any feelings of indifference as to the welfare of the poor.

Ecclesiastical and collegiate bodies have much to answer for in this respect, and one can only hope they will make up for the past by better attention to it for the future.

There is also another mischief in letting cottages to a greater extent than is absolutely necessary with the farms; it introduces a sort of truck system, and is very often a means of oppressing the labourer; the employer deducting more than a reasonable weekly rent from his wages on a Saturday night. The difficulty of getting cottages sometimes obliges the labourer to submit to this, although he may have work offered him on better terms elsewhere.

On this subject of crowded cottages, and the immorality it leads to, I will quote the following words of Mr. Justice Coleridge, addressed to a Labourers' Friends Association in Devonshire, and which I read in the public journals some time ago. Coming from such authority and experience, they are deserving of the highest attention.

"I beg to impress upon you the importance of improving the moral and social condition of the labouring classes, with whose well-being your own interest is very closely identified. Many amongst them are wretchedly lodged. From my own experience as a judge, the painful conviction has been forced upon my mind, that very much of the crime which disgraces our country is mainly attributable to the mixture of sexes and of ages in the dwellings of the poor; a practice that debases and demoralizes the human mind, and which, unless counteracted, must effectually neutralize every effort made towards the elevation or improvement of the people." This is a very strong opinion; but it is the opinion of one who has had the best opportunity of inquiring into crime, and he speaks of it as being forced upon him, and it is one to which every inquiring mind must come that has witnessed the low and degrading habits to which such practices lead. It is the duty

of owners of property to do all they can to remedy it, as it is no less the duty of the poor to second their efforts in doing so; but such is the force of habit, that in many cases where the landlord has attempted a remedy, the cottagers themselves have taken in lodgers; or when a son or daughter marries, let them have a part of their cottage,—a proof that any great improvement in this way must be a work of time, and can only be accomplished by degrees, as the rising generation become better educated, and more alive to social comforts, and feel that such habits lead to vice and misery, and make them every way as a class less respectable, not only in their own eyes, but in the eyes of their employers.

The present generation of children of the labouring class, now leaving school, have great difficulties and temptations to contend with; they are immediately thrown with companions who have not had the same advantages in this respect as themselves—having confirmed habits of a kind which education is intended to correct—jealous of those who have had any education whatever, and anxious to bring them in every way to a level with themselves—so that they have, in fact, more than ordinary temptations to resist.

Nor does this apply merely to their companions and fellow-labourers working in the same occupation with themselves, but to a very great number of others—the jeerers and scoffers, who are continually saying, "what do we want with this or with that? a little reading and writing is all that the labouring man can want;" so that, for the present, the better educated can only be looked upon as a leaven to leaven the mass, and that from the numerous temptations they meet with, there may be those, and no doubt will, who fall into the low and degrading habits of those about them; but every succeeding year will, in this respect, bring a brighter prospect with it, and education will in the end lead to that improvement in society at large which its friends have reason to expect: every one now leaving our schools at all educated as a pioneer among these rough samples of humanity, smoothing the way for a better order of things, and gradually making it smoother with each succeeding year.

The ignorance of some in the labouring classes can scarcely be understood by those who have not examined into it; and I have met with instances myself, particularly of lads just

growing into manhood, whose ignorance is greater than I could have imagined possible. The parents, after the age of twelve or even before that, lose all control over them; they have nothing to guide them beyond mere animal impulse, and of course this guides them wrong—to improve them at this age and with such habits is almost hopeless, and in whatever light you view them, it must be with feelings of pity and commiseration. Characters of this kind are in such a state, and their minds are become so completely inactive, that they work wickedness mechanically and from habit, having no idea whatever of the light in which it appears to the respectable part of society about them.

In extending education, and introducing it into our schools in such a way as to reach the classes above the labourer, we might hope that more of intelligence would be brought to bear on parochial management—in those things of a civic kind, which regard our living together in small separate communities—the parts of a whole, and working together for the general good, and having to carry into effect those internal arrangements among ourselves which the law requires for the happiness of the whole—things in which society at large is deeply interested; but, notwithstanding this, they are too generally transacted in a way which loses sight of every business principle, as well as of every principle of common sense.

In matters of this kind, it is painful to see the low standard of moral feeling which prevails in the agricultural districts, and the little regard which is paid that the public-houses, beer-houses, &c., and those places to which the labouring man resorts, should be kept within the bounds of decency, so that from the character of those who keep them, the poor man may in some measure be protected from falling into the degraded and mischievous courses, into which many of them have been led by frequenting ill-conducted places of the kind. It has been thought somewhat of a safeguard to the morals of a parish, that the keeper of a beer-house should, in order to get a license from the excise, produce a certificate signed by six inhabitant rate-payers, rated above £6 per annum, and in theory this might seem to read well, but in practice it is found to be no protection whatever, as to regulating the number of beer-houses, and proportioning them to the population, or as to the respectability of the party to be licensed; and I can

state, from my own experience, as well as from the evidence of others, that there is no character however bad, where six rate-payers in a moderate-sized parish may not be found to sign such certificate—either from what they please to term good-nature—or from a thorough indifference as to the mischief which may arise from it—or from a kind of bribery among the parties. I know instances annually occurring, where one might have supposed scarcely six men could be found in a whole county to sign such a recommendation, much less in a parish. The mischief which this leads to, and the demoralizing effect which such practices have upon the more ignorant class of labourers, and particularly among the young men, is most deplorable, and a better state of things can only arise by the class immediately above the labourer, as well as the labourer himself, being from education brought to feel that such conduct is discreditable to themselves, and is looked upon as such by the respectable classes immediately above them, and by thus being made to see their own conduct, in somewhat the same light as others see it—in the words of the poet of Scotland—

> "Oh, wad some power the giftie gie 'em
> To see themselves as others see 'em."

In general, the rule of conduct in such matters seems to be—if a man can get a living, that he is justified in doing anything which puts a penny into his pocket, no matter how much his doing so may bring into temptation and into mischief those about him. The poor labourers are many of them, in the winter, led to the beer-house by the warmth which it affords, and the result is, a starving wife—ragged and uneducated children—a brutalized peasantry—and many other evils, which might at all events be materially mitigated by a different conduct on the part of their employers, and by their taking a proper interest in the moral well-being and respectability of those around them, and towards whom they are, as beings, responsible to a higher power, and from a duty both to God and man, called upon to act in a very different way from that in which the generality of them do.

The peasantry, in the south of England more particularly, have lost all feeling of self-dependence, and are by no means characterised by those feelings of manly reliance on their own exertions, for the support of themselves and those who are

dependent upon them, which belong to the better educated peasantry of Scotland, and in one particular thing the contrast has struck me very forcibly—that is, with respect to those of their children, male or female, who may happen to be in any way disabled in body from following what may be called hard work: in the south of England, where this is the case, there is scarcely one parent in ten, nay, one in a hundred (at least I have found it so in my own parish, and hear of it in others), who does not, at the time his child is about sixteen, go to the clergyman of the parish for a certificate of its baptism, to lay before the board of guardians as soon after the child is sixteen as possible, in order to ask relief:—in Scotland, the feeling is, that parent and child, child and parent, should mutually assist each other. In England, on neither side does this feeling exist, and in conversing with Scotch people on this subject, there is nothing in which I have found them so much astonished, as in this difference of feeling among the peasantry of the two countries.

As an instance of the very strange notions which the poor have as regards the social relations existing between themselves and the parish, the following, although it may appear somewhat ludicrous, gives a very graphic and a very true idea. Being asked by an old man to send in his name as a claimant of a prize from the Local Agricultural Association, from his having been a number of years a member of what is called a Benefit Society, I did so, stating to him I did not think the case likely to succeed. I happened to see him soon after, and told him that he had not succeeded, and his answer to me was—"Why, sir, there's ne'er a man in the parish desarved it half so well as I did; I have had three wives, and I married them all out of the workhouse." Now, this man was of respectable character—of average intelligence, and well conducted, and his answer was meant in all earnestness; he really thought he had done the parish a service, in relieving it of the expense, at the time of his marriage, of his respective wives.

This is but one of many cases which I could relate, evidencing the great want of better instruction on economic subjects—not only among the labourers, but among the classes above them in our rural districts, and if any one thoroughly acquainted with them would bring before the public a fair,

honest, and, as far as possible, a graphic description of the real social evils of rural life, he would render great service to the cause of civilization, and would, by laying bare those vices, many of which arise from mere ignorance, advance, at the same time, the cause of that better education among the labouring masses of this country, which all but an unanimous feeling in the public mind seems at the present moment to be in favour of.

That these evils have arisen to the extent to which they now prevail, one reason among others is, I think, the erroneous view which many of the clergy have taken, that to correct and expose evils of this kind is not within the sphere of their duty—that it is of too secular a nature, and on that account that they ought not to interfere. In answer to this I would ask, is it a part of the clergyman's duty to try and make men honest, or is it not?—to make them tell the truth both in speaking and acting, and not to allow them to imagine themselves to be acting a charitable and a kind part, when in reality they are doing no such thing?—to see the poor crowded into cottages in such a way as to bid defiance to any possibility of their practising habits of decency, or of being brought up in them?—to see men nominally employed on the parish roads under a plea of humanity, when, in fact, it is to run them on in a sort of straw-yard* during the winter at a small expense, until their services may again be wanted?—in short, to allow the most erroneous notions on all subjects of a social kind to prevail without any attempt at amendment, from a fear, perhaps, of being classed among those taking too great care of earthly things, when the doing so might be the means of checking some of the most demoralizing influences which prevail among our labouring poor in the agricultural districts?

I know parishes where, for a long series of years, at least 75 per cent. of the money spent on their roads has been absolutely thrown away, the value of the work actually done not being 25 per cent. of the expenditure, the road rate having become a poor rate for the able-bodied, who are employed at a rate of wages varying with the number of their families, the term roadman being used for and in every way synonymous with the

* A parish workshop—a sort of Louis Blanc-ism on a small scale—carrying out in a parish what he wished to carry out in a nation, and with like result.

word pauper—and what is almost unaccountable, is, the rate-payers themselves being perfectly persuaded, or at least appearing to be so, that they are doing what is right, and the surveyor making oath every year before the magistrates that he has expended the parish money in such a way as the statutes relating to the highways direct. The effect of all this where it prevails, and in a greater or less degree it prevails extensively, is bad beyond description, and it is almost impossible to imagine the mischief to which it leads—in demoralizing the labourers as a class—in unduly keeping down the rate of wages and the proper remuneration of labour, and the in every way low and degraded state to which it leads.

Now if the object of religion be (what I think every one must confess it is) to make men practically good, then I think it must be allowed by all that its teachers are by no means exceeding their duty, in endeavouring to give clearer and better views in those matters nominally of a civil kind, having so intimate a relation and so direct an influence on the morals of a people, and in the healthy administration of which, almost all the links in our social chain are equally interested.

There is no subject on which both the labourer and the employer in our rural districts require more to be enlightened than on their mutual relations with respect to the Remuneration of Labour—a thing necessary before there can be any great change in the character of the labourer in this country—before he can feel that it is a sort of moral degradation for a healthy able-bodied man to throw himself (and in the present state of things he is obliged to do so) upon the parish the moment he is out of work. Nor can the farmer think, nor does he in fact think, that the labourer is wrong in doing so. Now, in blaming the labourer for doing this, and for having so little of a spirit of independence as to throw himself unscrupulously upon the parish the moment he is sick or out of work—every one must feel that it is in reality a part of his wages, and this is implied—between both parties—the employer and the employed—the present system of wages always supposes a third party to the contract—the parish, and never contemplates anything beyond getting on from one Saturday night to another, and in case of sickness or work failing, the

parish do the rest. A system like this necessarily leads (and we all know what in past times it has led to) to an unhealthy state of society; each individual employer is willing to save himself as much as possible, in order to throw the rest on the general rate-payer—the labourer from ignorance has lost sight of his true interests, and of what constitutes respectability and self-dependence; he is become improvident, without forethought, these being in his case not at all necessary, and is quite as contented to take part from his employer and part from the parish, as if he had the whole at once; perhaps more so, as in the one case it would imply he must take care of himself in case of sickness, want of employment, &c.; and in the other, he is taken care of by others; but at all events, the present system treats the labourer through life as a child that cannot take care of itself—as one that neither reflects upon the past, nor looks forward to the future.

The following passage from Mrs. Marcet's 'Conversations on Political Economy' well expresses what ought to be the tendency of the education given to the labouring classes; she says:—

"I would endeavour to give the rising generation such an education as would render them not only moral and religious, but industrious, frugal, and provident. In proportion as the mind is informed, we are able to calculate the consequences of our actions; it is the infant and the savage who live only for the present moment; those whom instruction has taught to think, reflect upon the past and look forward to the future. Education gives rise to prudence, not only by enlarging our understanding, but by softening our feelings, by humanising the heart, and promoting amiable affections. The rude and inconsiderate peasant marries without either foreseeing or caring for the miseries he may entail on his wife and children; but he who has been taught to value the comforts and decencies of life, will not heedlessly involve himself and all that is dear to him in poverty and its long train of miseries."

It certainly appears to me to be the true theory of a healthy state of society, and certainly more consistent with honest, straightforward conduct in all parties—(for the other leads to a great deal of low cunning)—more consistent with the rights of industry—that the wages of labour should, in the case of

the industrious man, be equal to all the decent wants of his class—house-rent, food, clothing, education; and in all cases of ordinary sickness, medical attendance—that the labourer should feel that it belongs to himself and to his own character as an honest man to provide all these things for himself and for his family—to feel happy in providing them every comfort within his reach; but then it is equally necessary that the employer of labour should view the matter in the same light. And although it may be difficult to arrive at this, yet it is to be hoped the tendency of education will be to point in this direction, and to enlighten both as to their true interests—that the one will respect the rights of honest industry—that the other will no less duly estimate what is owing to the employer who acts on this straightforward, manly, and honest principle (and which ought to be the commercial principle); which, although making the labourer earn his living by the sweat of his brow, would place him in a situation of decent comfort—happy in himself and in his family around him—happy in the blessings which this life affords him,* and equally happy in looking forward to leave it, when it shall please God to call him.

* "The common benefits of our nature entirely escape us; yet these are the great things. These constitute what most properly ought to be accounted blessings of Providence: what alone, if we might so speak, are worthy of its care. Nightly rest and daily bread, the ordinary use of our limbs, and senses, and understandings, are gifts which admit of no comparison with any other. Yet because almost every man we meet with possesses these, we leave them out of our enumeration. They raise no sentiment: they move no gratitude."—PALEY's *Natural Theology*.

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APPENDIX (A.)

The following extracts are from an Educational Tour in Germany by Horace Mann, Esq., Secretary to the Board of Education, Mass., U.S.; they are made for the purpose of recommending linear drawing to school teachers, a thing not much practised in our schools, but of the usefulness of which there can be no doubt.

Speaking of one of the first schools he entered, he says: "The teachers first drew a house on the black board, and here the value of the art of drawing—a power universally possessed by Prussian teachers—became manifest.

"The excellence of their writing must be referred, in a great degree, to the universal practice of learning to draw contemporaneously with learning to write. I believe a child will learn both to draw and to write sooner, and with more ease, than he will learn writing alone. I came to the conclusion that, with no other guide than a mere inspection of the copybooks, I could tell whether drawing were taught in the school or not—so uniformly superior was the handwriting in those schools were drawing was taught in connection with it.

"I never saw a teacher in a German school make use of a ruler, or any other mechanical aid, in drawing the most nice or complicated figures. I recollect no instance in which he was obliged to efface a part of a line because it was too long, or to extend it because it was too short. If squares or triangles were to be formed, they came out squares or triangles without any overlapping or deficiency. Here was not only much time gained or saved, but the pupils had constantly before their eyes these examples of celerity and perfectness, as models for imitation. No one can doubt how much more correctly, as well as more rapidly, a child's mind will grow in view of such models of ease and accuracy, than if only slow, awkward, and clumsy movement, are the patterns constantly held before it."

The following passage on the subject of teaching geography, as taught in the Prussian schools, is well worthy of the teacher's attention: Here the skill of the teacher and pupils in drawing does admirable service. I will describe, as exactly as I am able, a lesson which I heard given to a class a little advanced beyond the elements, remarking that, though I heard many lessons on the same plan, none of them were signalised by the rapidity and effect of the one I am about to describe.

"The teacher stood by the black board with the chalk in his hand. After casting his eye over the class, to see that all were ready, he struck at the middle of the board: with a rapidity of hand which my eye could hardly follow, he made a series of those short divergent lines, or shadings, employed by map engravers to represent a chain of mountains. He had scarcely turned an angle, or shot off a span, when the scholars began to cry out 'Carpathian Mountains, Hungary; Black Forest Mountains, Wurtemberg; Giants' Mountains (Riesen-gebirge), Silesia; Central Mountains (Mittel-gebirge), Bohemia,' &c.

"In less than half a minute the ridge of that grand central elevation,

which separates the waters that flow north-west into the German Ocean from those that flow north into the Baltic, and south-east into the Black Sea, was presented to view—executed almost as beautifully as an engraving. A dozen wrinkled strokes, made in the twinkling of an eye, represented the head waters of the great rivers which flow in different directions from that mountainous range; while the children, almost as eager and excited as though they had actually seen the torrents dashing down the mountain sides, cried out, 'Danube, Elbe, Vistula, Oder,' &c. The next moment I heard a succession of small strokes, or taps, so rapid as to be almost indistinguishable, and hardly had my eye time to discern a large number of dots made along the margins of the rivers, when the shout of 'Linz, Vienna, Prague, Dresden, Berlin,' &c., struck my ear. With a few more flourishes, the rivers flowed onwards towards their several terminations, and, by another accession of dots, new cities sprang up on their banks. Within ten minutes from the commencement of the lesson there stood upon the black board a beautiful map of Germany, with its mountains, principal rivers, and cities, the coast of the German Ocean, of the Baltic, and the Black Seas, and all so accurately proportioned, that I think only slight errors would have been found, had it been subjected to the test of a scale of miles. A part of this time was taken up in correcting a few mistakes of the pupils, for the teacher's mind seemed to be in his ear as well as in his hand; and, notwithstanding the astonishing celerity of his movements, he detected erroneous answers, and turned round to correct them. Compare the effect of such a lesson as this, both as to the amount of the knowledge communicated, and the vividness, and of course the permanence of the ideas obtained, with a lesson where the scholars look out a few names of places on a lifeless atlas, but never send their imaginations abroad over the earth; and where the teacher sits listlessly down before them to interrogate them from a book in which all the questions are printed at full length, to supersede, on his part, all necessity of knowledge."—MANN'S *Educational Tour in Germany.*

The following from an article in the 'Quarterly Review,' on Physical Geography, affords an instructive hint.

"Of the thirty-eight millions of square miles, forming in round numbers the total area of land, nearly twenty-eight millions lie to the north of the equator; and if we divide the globe longitudinally by the meridian of Teneriffe, the land on the eastern side of this line will be seen greatly to exceed the western; another manner of division into two hemispheres, according to the maximum extent of land and water in each, affords the curious result of designating England as the centre of the former or terrene half—an antipodal point near New Zealand as the centre of the aqueous hemisphere. The exact position in England is not far from the Land's End; so that if an observer were there raised to such height as to discern at once one half of the globe, he would see the greatest possible extent of land; if similarly elevated in New Zealand, the greatest possible surface of water.

"An increase of land above the sea between the tropics raises the mean temperature, in higher latitudes depresses it; and every such vicissitude must be attended with some corresponding change in the nature and conditions of organic life."

APPENDIX (B).

The *arithmetical constants* given below, with the tabular matter on the different subjects to which the tables relate, will, in the higher class of schools, be found of great service. Some of the walls of the class-room in the King's Somborne school are plastered, and the following matter, in a tabulated form, written upon them, in letters and figures of about an inch in size. They not only suggest observations during the progress of a lesson connected with the subject of them, but they accustom the teacher to something like arithmetical accuracy in making such observations, and enable the children to form ideas of a definite kind, and make the subjects perfectly intelligible; in fact, knowledge communicated in this way makes them close and accurate reasoners, and it is astonishing to see how much they get interested in it. These tables also suggest numberless questions in arithmetic which may be given by a teacher. In giving them here, it is merely to suggest the same thing to others, and in schools, where such information is not a part of their teaching, tabular matter, connected with the ordinary weights and measures—the number of cubic inches in a solid yard, in a quart, and other measures, might supply its place on the walls of the schoolroom.

From Table I.—In comparing the rapidity of the motion of a cannon-ball with that, for instance, of the swallow, the teacher would point out the necessity of reducing them to spaces passed over in the same time, when it will be found that the cannon-ball moves at the rate of more than 1300 miles per hour, the swallow, 90; that one is a velocity so great that the eye cannot see the object moving; that there is an intermediate velocity between the two, with which, if the ball moves, it ceases to be invisible, and that it will be gradually reduced to this before its motion ceases—after striking the ground—which is called a spent ball; that the flight of the bird may be supposed to be so increased, as not to be seen in passing from one point of space to another, &c.

The outline of Table VIII, which is only partially filled up, would suggest many observations of a meteorological kind—why points of equal temperature on the surface of the earth do not follow the simple rule of distance from the equator; how affected by sea, land, mountains; accounting for the zigzag nature of isothermal lines, &c. It would also be found very useful to draw on the ceiling of the school- or class-room lines running in the direction of the four cardinal points, with a line representing the magnetic meridian in degrees, and the magnitude of the angle of variation written between them.

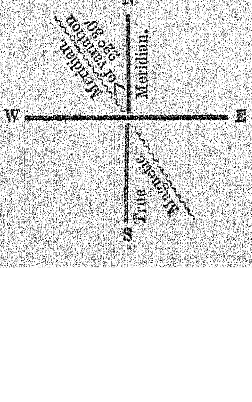


TABLE I.—*Numerical Constants.*

⊙^ce of a circle, dia. 1	3·14159
Area of do.	·7854
⊙^ce of a circle, dia. D . . .	(3·14159) D
Area of do.	$(\cdot7854)D^2$
Length of Arc 1° dia. 1	·008726645
Sol. cylinder *Ht* D and dia. of Base D	$=(\cdot7854)\ D^3$
,, of sphere = ⅔ of cylinder	$=(\cdot5236)\ D^3$
Surface of do. dia. D	$(3\cdot14159)\ D^2$
A body falls by gravity . . .	$16\frac{1}{12}$ feet in 1″
,, ,, . . .	$(16\frac{1}{12})\ t^2$ in t''
Length of a pendulum vibrating seconds in lat. 51° 31′ .	= 39·1386 inches.
Velocity of sound	1142 feet in 1″
,, of a cannon-ball . . .	2000 feet in 1″
,, of light	200,000 miles in 1″
,, of rotation of point at equator	1520 feet per second.
,, of a point in lat. 51° . .	830 ,,
,, of quick train railroad .	88 ,,
,, (mean) of rivers 3 or 4 feet per second.	
,, of a brisk wind	10 miles per hour.
,, of a high wind, about .	40 ,,
,, of a hurricane . . .	80 ,,

Most rapid flight of a swallow, about 80 to 90 miles per hour.

TABLE II.—*Specific Gravity, Distilled Water*=1·000.

METALS, And other Inorganic Bodies.

Platinum	22·069	Zinc . .	7·100
Gold . .	19·258	Sodium .	0·973
Mercury .	13·586	Potassium	0·865
Lead . .	11·352	Chalk . .	2·784
Silver .	10·474	Limestone	3·179
Copper .	8·788	Marble .	2·742
Steel .	7·812	Flint and Spar .	2·594
Iron (bar)	7·788		
Iron (cast)	7·207	Common Glass .	2·642
Tin . . .	7·291		

ORGANIC BODIES.

Dry Oak	·925
,, Beech	·852
,, Ash	·845
,, Elm	·600
,, Cedar	·561
,, Larch	·498
,, Poplar	·383
,, Cork	·240
,, Ivory	1·826
,, Bones of Oxen . .	1·656

LIQUIDS.

Sea Water . . .	1·026
Milk	1·030
Oil of Olives . . .	0·915
Alcohol	0·792
Ether	0·715
Nitric Acid . . .	1·503
Sulphuric Acid . .	1·845
Ammonia	0·960
Weight, in ounces, of a cubic foot of water, temp. 63° . .	997.136
Ditto in lbs. . . .	62·321

GASES.

Atmospheric Air . .	1·000
Oxygen	1·111
Nitrogen	0·972
Hydrogen	0·069
Chlorine	2·500
Ammonia	0·590
Carbonic Acid . . .	1·527
Weight, in ounces, of a cubic foot of air	1·24642
Ditto in lbs. . . .	·0779

TABLE III.*

Height of Barometer. Inches.	Corresponding temperature at which water boils. Fahrenheit.
26	204·91°
26·5	205·79
27	206·67
27·5	207·55
28	208·43
28·5	209·31
29	210·10
29·5	211·07
30·0	212·00
30·5	212·88
31·0	213·76

These inches of mercury measure also the elastic force of the vapour of water at the same temperature.

TABLE IV.

Melting Points of different Substances.

	Fah.
Heat of common fire	790°
Iron red in the dark	750
Beeswax	136
Lard	97
Tallow	127
Tin, 3. Lead, 2	334
Tin, 1. Lead, 4	460
Lead	612
Zinc	680
Antimony	809
Brass	3809
Copper	4587
Silver	3937
Gold	5237
Soft Nails	21097
Iron	21637
Platinum	23177

TABLE V.

Boiling Points of different Liquids.

	Fah.
Water	212°
Ether	96
Alcohol	176
Most essential oils	212
Water saturated with common salt	225
Oil of Turpentine	316
Sulphuric Acid	590
Linseed Oil	600
Mercury	660
Nitric Acid	218
Phosphorus	554
Sulphur	570

TABLE VI.—*Freezing Points of Liquids.*

	Fah.
Water freezes	32°
Milk	30
Olive Oil	36
Salt Water, 1 part salt, 4 parts water	7
Brine, 1 part salt, 3 water	4
Mercury	— 39°
Vinegar	+ 28
Oil of Turpentine	+ 16
Sulphuric Acid	+ 46
Human Blood	+ 25
Brandy	— 7

* Tables III, IV, V, VI, from Lardner's Cyclopædia, volume on Heat.

Table VII.

Linear Dilatation.

Of Solids by Heat.

Dimensions at 212° of a bar whose length at 32° is 1·00.*

		Vulgar Fractions.
Glass Tube	1·00082800	$\frac{1}{1116}$
Platina	1·00088420	$\frac{1}{1131}$
Cast Iron	1·001111	—
Steel	1·00118980	—
Iron Wire	1·0014401	—
Iron (Dulong)	1·00118203	$\frac{1}{846}$
Gold	1·00146606	$\frac{1}{682}$
Copper	1·00172244	$\frac{1}{581}$
Silver	1·00190974	$\frac{1}{524}$
Tin	1·00217298	$\frac{1}{462}$
Lead	1·00284836	$\frac{1}{351}$
Zinc	1·00294200	—

Of Liquids by Heat.

From 32° to 212°.

		Vulgar Fractions.
Mercury	0·01800	$\frac{1}{55}$
Alcohol (Dalton)	0·1100	$\frac{1}{9}$
Water ,,	0·04444	$\frac{1}{22}$
Water, saturated with common salt	0·0500	$\frac{1}{20}$
Fixed Oils	0·0800	$\frac{1}{125}$
Oil of Turpentine	0·0700	$\frac{1}{41}$
Sulphuric Acid	0·0600	$\frac{1}{17}$
Nitric Acid	0·1100	$\frac{1}{9}$
Whale Oil	0·08548	—

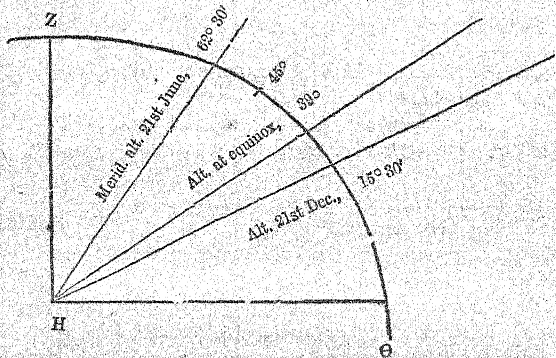
* From Ure's Dictionary of Chemistry.

TABLE VIII.

PLACES.	Latitude.	Longitude.	Elevation in feet above Sea Level.	Snow Line. Between	Variation of the Needle.	Inches of Rain in the Year.	Mean Temperature of the Year.	Winter.	Spring.	Summer.	Autumn.	Coldest Month.	Hottest Month.
				Feet.									
London . .	51° 30′ N.	0°	218·5	5 & 6000	22° 30′ W.	23	55·4	41·45	53·37	70·47	56·07	38·75 Jan.	72·05 July
Edinburgh .	55° 57′	7° 58′ W.	288·71				51·35	40·1	49·1	64·4	52·02	38·5 Jan.	65·75 July
Paris . .	48° 50′	2° 26′ E.	193·3	6 & 10,000			56·3	39·42	55·17	72·72	57·02	36·05	74·52
Madrid . .	40° 25′	8° 28′ W.	2175·19	10,000			63·95	44·6	63·95	84·65	62·82		
Vienna . .	48° 13′	16° 29′ E.	518·81	6 & 10,000			54·7	32·45	55·62	77·67	55·62	28·6	68·57
Petersburg	59° 56′	30° 25′		5000		16	39·85	13·10	35·82	68·00	43·00	9·00 Jan.	70·25 July
St. Bernard	45° 50′	7° 11′	8606·00	6 & 10,000			34·25	14·45	27·5	45·72	32·9	11·00 Jan.	47·5 Aug.
Cape of Good Hope	33° 35′ S.	18° 34′		10 & 14,000			74·97	65·3	73·85	84·65	75·65	64·17 Aug.	86·9 Jan.
Calcutta . .	22° 35′ N.	88° 26′		17,000		81	96·12	76·77	95·22	96·12	90·72	73·4 Jan.	99·27 May
Quito . .	0° 14′ S.	83° 31′ W.	9560·34	16,000			67·10	66·65	67·32	67·1	71·37	65·3 July	68·67 Mar.
Rome . .	41° 54′ N.	12° 34′ E.	173·88			38	66·65	50·2	63·60	82·50	69·00	47·75 Jan.	86·00 July
North Cape	71° 10′	25° 56′					34·25	21·75	29·00	46·50	32·00	20·75 Jan.	50·2 July
Jakutyk on the Lena	62° 1′	129° 13′	383·857	1 & 5000			*10·18	*55·52	13·33	70·7	17·15	*41·0 Feb.	77·75 July

* On the —ve side of zero.

A figure like the following, in the Somborne School, on the wall a the east end of the class room, showing the meridian altitude of the sun on the shortest and longest days, and at the equinoxes, may be made the means of giving children a good idea of his varying meridian altitude at different times of the year—varying influence arising from this on the vegetable and animal kingdom, &c.



APPENDIX (C).

A List of some of the Philosophical and other Apparatus used in the King's Somborne School.

A geological map of England.
A pair of globes.
A compass, a spirit level, a measuring chain, and models of the simple geometrical solids.
A set of mechanical powers, lever, wheel, and angle, &c., apparatu for illustrating centrifugal force, &c.
A pair of common bellows.
Glass model of a common pump.
Glass model of a diving-bell.

Air-pump and receivers, &c., with other apparatus for various experiments.

Brass bottle-balance for weighing air, gases, &c.

Apparatus for finding specific gravity of bodies.

Apparatus for showing elasticity of steam.

A sectional model of a steam-engine.

Apparatus on heat, &c.—barometer, thermometer, pyrometer.

Apparatus for showing the different conducting powers of metals.

Leslie's parabolic reflectors.

Three plane circular discs of white metal, on stands, one smooth, one scratched, one blackened for experiments on the absorption and radiation of heat.

A vessel in the shape of a cube, with faces of different kinds for ditto.

Leslie's differential thermometer.

A magic lantern, with astronomical and other slides.

Glass prisms, lenses, &c., of different kinds.

A small chemical apparatus.

Pneumatic trough, bell-jar, &c., with stop-cock, &c., for collecting and decanting gases, retorts, &c.

Spirit-lamp, argand-lamp, oxyhydrogen blowpipe, Davy lamp.

A voltaic battery—apparatus for showing Oersted's experiment—the principle of the electric telegraph—magnets, &c.

A small electric cylindrical machine, glass, and sealing-wax, rods, and pith-balls, stools, with glass legs, Leyden jars, discharging rods, electrometers, &c.

A number of small things, which it would be tedious to make a list of, but which have grown up here by degrees, would suggest themselves to a teacher as he proceeds.

The list given is for the purpose of suggesting to others, things which have been found by experience highly useful; but the instruction is *not* in the instruments themselves, but in the use which is made of them.

A teacher having a knowledge of these subjects may give a great deal of useful instruction illustrative of every-day life, by means of simple apparatus of no very expensive kind. This should be added to as the wants of the school require, for fear of incurring expense by the purchase of things which the teachers might not be able to turn to good account.

THE END.

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